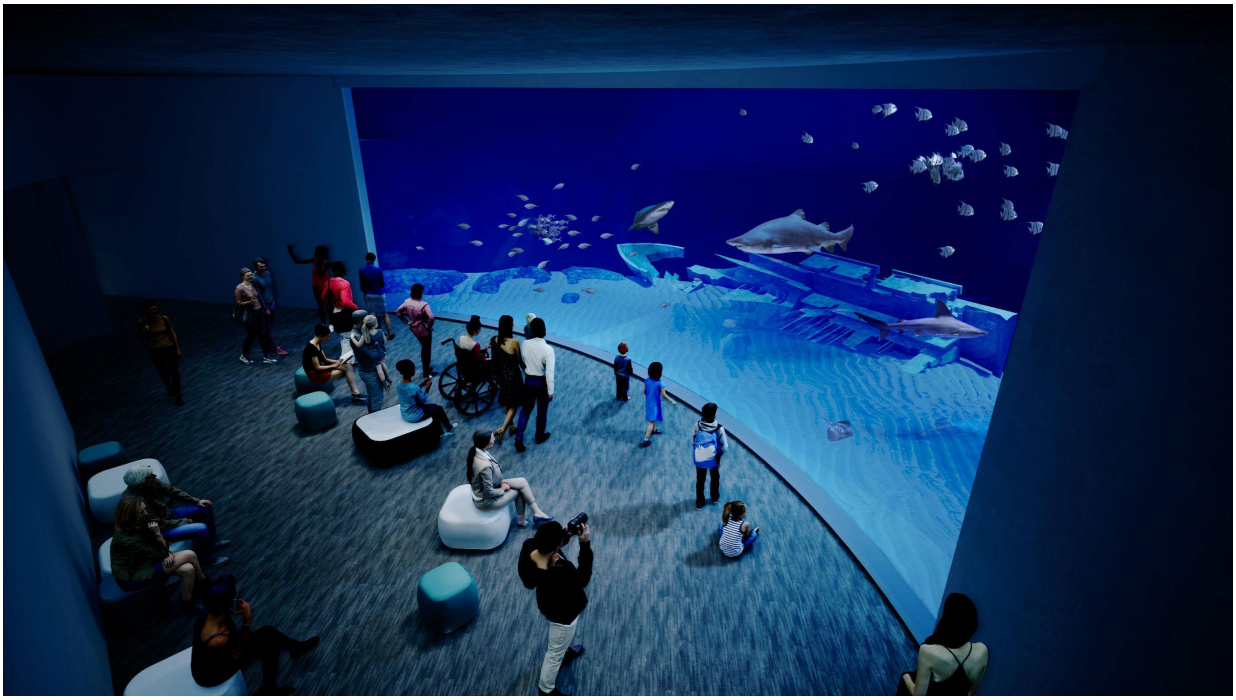
CONSTRUCTION DOCUMENT SPECIFICATION

FORT FISHER AQUARIUM RENOVATION & EXPANSION

SCO # 17-18042-02A

Kure Beach, North Carolina



8 AUGUST 2025

Szostak Design, Inc.
Chapel Hill, NC

DESIGN DEVELOPMENT SPECIFICATIONS FOR:

Fort Fisher Aquarium Renovation & Expansion

900 Loggerhead Rd
Kure Beach, NC 28449

Owner

NC Dept of Natural & Cultural Resources
3125 Poplarwood Ct, Suite 160
Raleigh, NC 27604

Contact Person:
James Mancari, Division Project Manager
NC Aquariums
919.877.5500
james.mancari@ncaquariums.com

Architects

Szostak Design, Inc.
310 ½ Franklin Street
Chapel Hill, North Carolina 27516

Contact Person:
Phil Szostak, Principal
919.929.5244
pszostak@szostakdesign.com

Plumbing, Mechanical, & Electrical Engineers

CBHF Engineers, PLLC
2246 Yaupon Drive
Wilmington, NC 28401
910.791.4000
dhahn@cbhfengineers.com

Structural Engineers

Bennett & Pless
5430 Wade Park Boulevard, Suite 400
Raleigh, NC 27607
919.832.5587
kperkins@bennett-pless.com

Life Support System Engineers

TJP Engineering, Inc.
56880 Venture Lane, Suite 205N
Bend, OR 97707
619.423.8700
tjohnson@tjpengineering.com

Exhibit Designers

Roto Group, LLC.
7001 Discovery Boulevard
Dublin, OH 43017
617.760.8690
jhartunian@roto.com

Civil Engineers

Tunstall Consulting Engineers PLLC
2602 Iron Gate Drive, Suite 102
Wilmington, NC 28412
910.343.9653
jtunstall@tunstallengineers.com

Landscape Architects

Surface678, PA
215 Morris Street, Suite 150
Durham, NC 27701
919.419.1199
rpratt@surface678.com

Fire Protection Engineers

Cheatham & Associates, PA
3412 Enterprise Drive
Wilmington, NC 28405
910.452.4210
cgilman@cheathampa.com

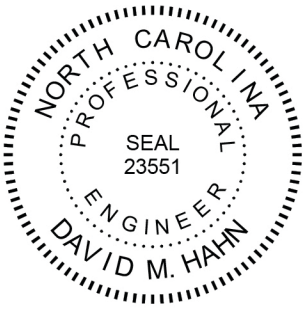
Lighting Designers

Lightswitch
10625 Indiana Court
Rancho Cucamonga, CA 91730
909.360.2900
wkong@lightswitch.net

Consultants' Corporate Seals:

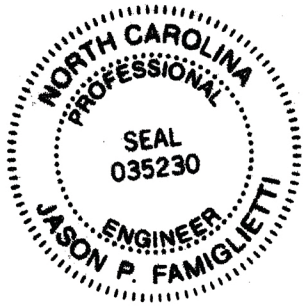




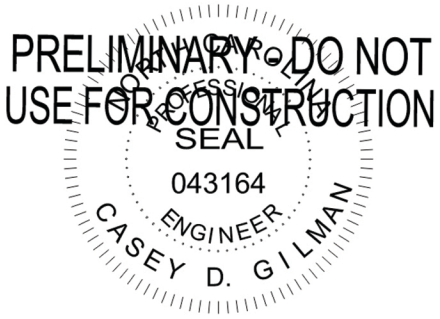


PRELIMINARY - DO NOT USE FOR CONSTRUCTION













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GENERAL CONDITIONS OF THE CONTRACT

STANDARD FORM FOR CONSTRUCTION MANAGER-AT-RISK PROJECTS

NORTH CAROLINA

DEPARTMENT OF ADMINISTRATION

STATE CONSTRUCTION OFFICE

Form OC-15CM

This document is intended for use on State capital construction projects and shall not be used on any project that is not reviewed and approved by the State Construction Office. Extensive modification to the General Conditions by means of "Supplementary General Conditions" is strongly discouraged. State agencies and institutions may include special requirements in "Division 1 – General Requirements" of the specifications, where they do not conflict with the General Conditions.

Second Edition January 2013
Revision 1 – May 2024: Article 23.b

GENERAL CONDITIONS OF THE CONTRACT

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ARTICLE 1 - DEFINITIONS

a. The **contract documents** consist of the Request for Proposal (RFP); Construction Manager's formal response to the RFP; General Conditions of the Contract; special conditions if applicable; Supplementary General Conditions; the drawing and specifications, including all bulletins, addenda or other modifications of the drawings and specifications incorporated into the documents prior to their execution; the contract; the performance bond; the payment bond; insurance certificates; the approval of the attorney general; and the certificate of the Office of State Budget and Management. All of these items together form the contract.

b. The **Owner** is the State of North Carolina by and through the agency or institution named in the contract.

c. The **designer** or **project designer** means the firm or firms of architects or engineers or both (and their consultants) which have undertaken to design the project pursuant to a contract with the Owner, (hereinafter, the "design contract").

d. The **Construction Manager-at-Risk (CM) accepts a relationship of trust and confidence between himself and the Owner and undertakes to act as the Owner's fiduciary in the handling and opening of bids in accordance with the provisions of North Carolina General Statute (N.C.G.S.) 143-128.1.** The CM agrees to furnish his best skills and his best judgment to cooperate with the Owner and Designer for undertaking all necessary action contemplated under the contract documents to (a) establish during the design phase a Guaranteed Maximum Price (GMP) to construct the project and (b) ensure timely and quality completion of the project at a cost within the GMP. Construction Manager or CM as used in the contract documents means Construction Manager-at-Risk (CM at Risk).

e. A **subcontractor**, as the term is used herein, shall be in the case of a principal trade contractor, a general, mechanical, electrical or plumbing contractor or in the case of a specialty contractor, a trade contractor who is not a principal trade contractor, who has entered into a direct contract with a CM, and includes one who furnishes materials worked to a special design in accordance with plans and specifications covered by the contract, but does not include one who only sells or furnishes materials not requiring work so described or detailed.

f. **Written notice** shall be defined as notice in writing delivered in person to the contractor, or to a partner of the firm in the case of a partnership, or to a member of the contracting organization, or to an officer of the organization in the case of a corporation, or sent to the last known business address of the contracting organization by registered mail.

g. **Work**, as used herein as a noun, is intended to include materials, labor, and workmanship of the appropriate contractor as supervised by the CM.

h. The **project** is the total construction work to be performed under the contract documents.

i. **Construction Management Fee** shall be an all-inclusive lump sum management fee which will include all Construction Manager-at-Risk home office, project site and project related costs including all Construction Manager-at-Risk overhead costs and profit.

j. **Change order**, as used herein, shall mean a written order to the CM subsequent to the signing of the contract authorizing a change in the GMP contract. The change order shall be signed by the CM, designer and the Owner, and approved by the State Construction Office, in that order (Article 19).

k. **Field Order,** as used herein, shall mean a written approval for the CM to proceed with the work requested by Owner prior to issuance of a formal Change Order. The field order shall be signed by the CM, designer, Owner, and State Construction Office (SCO).

l. **Field Change,** as used herein shall mean a written approval from the Owner for the CM to proceed with work requested by the Owner to be paid for from the CM Contingency or Owner's Project Reserve within the GMP.

m. **Time of Completion**, as stated in the contract documents, is to be interpreted as consecutive calendar days measured from the date established in the written Notice to Proceed, or such other date as may be established herein (Article 23).

n. **Liquidated damages,** as stated in the contract documents, is an amount reasonably estimated in advance to cover the consequential damages associated with the Owner's economic loss in not being able to use the Project for its intended purposes at the end of the contract's completion date as amended by change order, if any, by reason of failure of the CM to complete the work within the time specified. Liquidated damages does not include the Owner's extended contract administration costs (including but not limited to additional fees for architectural and engineering services, testing services, inspection services, commissioning services, etc.), such other damages directly resulting from delays caused solely by the CM, or consequential damages that the Owner identified in the bid documents that may be impacted by any delay caused solely by the CM (e.g., if a multi-phased project-subsequent phases, delays in start of other projects that are dependent on the completion of this Project, extension of leases and/or maintenance agreements for other facilities).

o. **Surety**, as used herein, shall mean the bonding company or corporate body which is bound with and for the CM, and which engages to be responsible for the CM and his acceptable performance of the work.

p. **Routine written communications between the Designer and the Construction Manager** are any communication other than a "request for information" provided in letter, memo, or transmittal format, sent by mail, courier, electronic mail, or facsimile. Such communications cannot be identified as "request for information".

q. **Clarification or Request for information (RFI)** is a request from the CM seeking an interpretation or clarification by the Designer relative to the contract documents. The RFI, which shall be labeled (RFI), shall clearly and concisely set forth the issue or item requiring clarification or interpretation and why the response is needed. The RFI must set forth the CM's interpretation or understanding of the contract documents requirements in question, along with reasons for such an understanding.

r. **Approval** means written or imprinted acknowledgement that materials, equipment or methods of construction are acceptable for use in the work**.**

s. **Inspection** shall mean examination or observation of work completed or in progress to determine its compliance with contract documents.

t. **"Equal to" or "approved equal"** shall mean materials, products, equipment, assemblies, or installation methods considered equal by the bidder in all characteristics (physical, functional, and aesthetic) to those specified in the contract documents. Acceptance of equal is subject to approval of the designer and owner.

u. **"Substitution" or "substitute"** shall mean materials, products, equipment, assemblies, or installation methods deviating in at least one characteristic (physical, functional, or aesthetic) from those specified, but which in the opinion of the bidder would improve competition and/or enhance the finished installation. Acceptance of substitution is subject to the approval of the designer and owner.

v. **Provide** shall mean furnish and install complete in place, new, clean, operational, and ready for use.

w. **Indicated and shown** shall mean provide as detailed, or called for, and reasonably implied in the contract documents.

x. **Special inspector** is one who inspects materials, installation, fabrication, erection or placement of components and connections requiring special expertise to ensure compliance with the approved construction documents and referenced standards.

y. **Commissioning** is a quality assurance process that verifies and documents that building components and systems operate in accordance to the owner's project requirements and the project design documents.

z. **Designer Final Inspection** is the inspection performed by the design team to determine the completeness of the project in accordance with approved plans and specifications. This inspection occurs prior to SCO final inspection.

aa. **SCO Final Inspection** is the inspection performed by the State Construction Office to determine the completeness of the project in accordance with NC Building Codes and approved plans and specifications.

bb. **Beneficial Occupancy** is requested by the owner and is occupancy or partial occupancy of the building after all life safety items have been completed as determined by the State Construction Office. Life safety items include but not limited to fire alarm, sprinkler, egress and exit lighting, fire rated walls, egress paths and security.

cc. **Final Acceptance** is the date in which the State Construction Office accepts the construction as totally complete. This includes the SCO Final Inspection and certification by the designer that all punch lists are completed.

ARTICLE 2 - INTENT AND EXECUTION OF DOCUMENTS

a. The drawings and specifications are complementary, one to the other. That which is shown on the drawings or called for in the specifications shall be as binding as if it were both called for and shown. The intent of the drawings and specifications is to establish the scope of all labor, materials, transportation, equipment, and any and all other things necessary to provide a complete job. In case of discrepancy or disagreement in the contract documents, the order of precedence shall be: Form of Contract, specifications, large-scale detail drawings, small-scale drawings.

b. The wording of the specifications shall be interpreted in accordance with common usage of the language except that words having a commonly used technical or trade meaning shall be so interpreted in preference to other meanings.

c. The CM shall execute each copy of the response to RFP, contract, performance bond and payment bond as follows:

1. If the documents are executed by a sole Owner, that fact shall be evidenced by the word "Owner" appearing after the name of the person executing them.

2. If the documents are executed by a partnership, that fact shall be evidenced by the word "Co-Partner" appearing after the name of the partner executing them.

3. If the documents are executed on the part of a corporation, they shall be executed by either the president or the vice president and attested by the secretary or assistant secretary in either case, and the title of the office of such persons shall appear after their signatures. The seal of the corporation shall be impressed on each signature page of the documents.

4. If the documents are made by a joint venture, they shall be executed by each member of the joint venture in the above form for sole Owner, partnership or corporation, whichever form is applicable to each particular member.

5. All signatures shall be properly witnessed.

6. If the construction manager's license is held by a person other than an Owner, partner or officer of a firm, then the licensee shall also sign and be a party to the contract. The title "Licensee" shall appear under his/her signature.

7. The bonds shall be executed by an attorney-in-fact. There shall be attached to each copy of the bond a certified copy of power of attorney properly executed and dated.

8. Each copy of the bonds shall be countersigned by an authorized individual agent of the bonding company licensed to do business in North Carolina. The title "Licensed Resident Agent" shall appear after the signature.

9. The seal of the bonding company shall be impressed on each signature page of the bonds.

10. The CM's signature on the performance bond and the payment bond shall correspond with that on the contract.

ARTICLE 3 - CLARIFICATIONS AND DETAIL DRAWINGS

a. In such cases where the nature of the work requires clarification by the designer, such clarification shall be furnished by the designer with reasonable promptness by means of written instructions or detail drawings, or both. Clarifications and drawings shall be consistent with the intent of contract documents, and shall become a part thereof.

b. The CM and the Designer shall prepare, if deemed necessary, a schedule fixing dates upon which foreseeable clarifications will be required. The schedule will be subject to addition or change in accordance with progress of the work. The Designer shall furnish drawings or clarifications in accordance with that schedule. The CM shall not proceed with the work without such detail drawings and/or written clarifications.

ARTICLE 4 - COPIES OF DRAWINGS AND SPECIFICATIONS

The Designer or owner shall furnish free of charge to the CM electronic copies of plans and specifications. If requested by the CM, up to 30 paper copies of plans and specifications will be

provide free of charge, plus a clean set of black line prints on white paper of all appropriate drawings, upon which the CM shall clearly and legibly record all work-in-place that is at variance with the contract documents. Additional sets shall be furnished at cost, including mailing, to the CM at the request of the CM.

ARTICLE 5 - SHOP DRAWINGS, SUBMITTALS, SAMPLES, DATA

a. Within fifteen (15) consecutive calendar days of the notice to proceed, a schedule for anticipated submission of all shop drawings, product data, samples, and similar submittals shall be prepared by the CM and provided to the designer. This schedule shall indicate the items, relevant specification sections, other related submittal data, and the date when these items will be furnished to the designer.

b. The CM shall review, approve and submit to the Designer all Shop Drawings, Coordination Drawings, Product Data, Samples, Color Charts, and similar submittal data required or reasonably implied by the Contract Documents. Required Submittals shall bear the CM's stamp of approval, any exceptions to the Contract Documents shall be noted on the submittals, and copies of all submittals shall be of sufficient quantity for the Designer to retain up to three (3) copies of each submittal for his own use plus additional copies as may be required by the CM. Submittals shall be presented to the Designer in accordance with the schedule submitted in paragraph (a). so as to cause no delay in the activities of the Owner.

c. The Designer shall review required submittals promptly, noting desired corrections if any, and retaining three (3) copies (1 for the Designer, 1 for the owner and 1 for SCO) for his use. The remaining copies of each submittal shall be returned to the CM not later than twenty (20) days from the date of receipt by the Designer, for the CM's use or for corrections and resubmittal as noted by the Designer. When resubmittals are required, the submittal procedure shall be the same as for the original submittal***s.***

d. Approval of shop drawings by the designer shall not be construed as relieving the CM from responsibility for compliance with the design or terms of the contract documents nor from responsibility of errors of any sort in the shop drawings, unless such error has been called to the attention of the designer in writing by the CM.

ARTICLE 6 - WORKING DRAWINGS AND SPECIFICATIONS AT THE JOB SITE

a. The CM shall maintain, in readable condition at his job office, one complete set of working drawings and specifications for his work including all shop drawings. Such drawings and specifications shall be available for use by the Designer or his authorized representative, owner or State Construction Office.

b. The CM shall maintain at the job office, a day-to-day record of work-in-place that is at variance with the contract documents. Such variations shall be fully noted on project drawings by the CM and submitted to the designer upon project completion and no later than thirty (30) days after acceptance of the project.

c. The contractor shall maintain at the job office a record of all required tests that have been performed, clearly indicating the scope of work inspected and the date of approval or rejection.

ARTICLE 7 - OWNERSHIP OF DRAWINGS AND SPECIFICATIONS

All drawings and specifications are instruments of service and remain the property of the Owner. The use of these instruments on work other than this contract without permission of the Owner is prohibited. All copies of drawings and specifications other than contract copies shall be returned to the Owner upon request after completion of the work.

ARTICLE 8 - MATERIALS, EQUIPMENT, EMPLOYEES

a. The CM shall, unless otherwise specified, supply & pay for all lighting, power, heat, sanitary facilities & water and shall require the Principal Trade and Specialty Contractors to, supply and pay for all labor, transportation, materials, tools, apparatus, scaffolding and incidentals necessary for the completion of his work, and to install, maintain and remove all equipment of the construction, other utensils or things, and be responsible for the safe, proper and lawful construction, maintenance and use of same. The CM shall construct in the best and most workmanlike manner, a complete job and everything incidental thereto, as shown on the plans, stated in the specifications, or reasonably implied there from, all in accordance with the contract documents.

b. All materials shall be new and of quality specified, except where reclaimed material is authorized herein and approved for use. Workmanship shall at all times be of a grade accepted as the best practice of the particular trade involved, and as stipulated in written standards of recognized organizations or institutes of the respective trades except as exceeded or qualified by the specifications.

c. Upon notice, the CM shall furnish evidence from the Principal Trade and Specialty Contractors as to quality of materials.

d. Products are generally specified by ASTM or other reference standard and/or by manufacturer's name and model number or trade name. When specified only by reference standard, the CM through the Principal Trade or Specialty Contractor may select any product meeting this standard, by any manufacturer. When several products or manufacturers are specified as being equally acceptable, the CM through the Principal Trade or Specialty Contractor has the option of using any product and manufacturer combination listed. However, the CM through the Principal Trade or Specialty Contractor shall be aware that the cited examples are used only to denote the quality standard of product desired and that they do not restrict bidders to a specific brand, make, manufacturer or specific name; that they are used only to set forth and convey to bidders the general style, type, character and quality of product desired; and that equivalent products will be acceptable. The CM shall be responsible for reviewing all substitution requests from Principal Trade or Specialty Contractors prior to submission to the Project Designer and Owner and shall track & monitor all such requests. Requests for substitution of materials, items, or equipment shall be submitted to the Project Designer for approval or disapproval; such approval or disapproval shall be made by the designer prior to the opening of bids. Alternate materials may be requested after award if it can clearly be demonstrated that it is an added benefit to the owner and the designer and the owner approves.

e. The CM shall obtain written approval from the designer for the use of products, materials**,** equipment**,** assemblies or installation methods claimed as equal to those specified. Such approvals must be obtained as soon after contract awards as possible and before any materials are ordered.

f. The Designer is the judge of equality for proposed substitution of products, materials or equipment.

g. If at any time during the construction and completion of the work covered by these contract documents, the conduct of any workman of the various crafts be adjudged a nuisance to the Owner or Designer, or if any workman be considered detrimental to the work, the CM shall order such parties removed immediately from grounds.

ARTICLE 9 - ROYALTIES, LICENSES AND PATENTS

It is the intention of the contract documents that the work covered herein will not constitute in any way infringement of any patent whatsoever unless the fact of such patent is clearly evidenced herein. The CM shall protect and save harmless the Owner against suit on account of alleged or actual infringement. The CM shall pay all royalties and/or license fees required on account of patented articles or processes, whether the patent rights are evidenced hereinafter.

ARTICLE 10 - PERMITS, INSPECTIONS, FEES, REGULATIONS

a. The CM shall give all notices and comply with all laws, ordinances, codes, rules and regulations bearing on the conduct of the work under this contract. If the CM observes that the drawings and specifications are at variance therewith, he shall promptly notify the Designer in writing. Any necessary changes required after contract award shall be made by change order in accordance with Article 19. If the CM performs any work or authorizes any work to be performed knowing it to be contrary to such laws, ordinances, codes, rules and regulations, and without such notice to the designer, he shall bear all cost arising there from. Additional requirements implemented after bidding will be subject to equitable negotiations.

b. All work under this contract shall conform to the North Carolina State Building Code and other State, local and national codes as are applicable. The cost of all required inspections and permits shall be the responsibility of the CM unless otherwise specified.

c. Projects constructed by the State of North Carolina or by any agency or institution of the State are not subject to inspection by any county or municipal authorities and are not subject to county or municipal building codes. The CM shall, however, cooperate with the county or municipal authorities by obtaining building permits. Permits shall be obtained at no cost.

d. Projects involving local funding (Community Colleges) are also subject to county and municipal building codes and inspection by local authorities. The CM shall pay the cost of these permits and inspections unless otherwise specified.

ARTICLE 11 - PROTECTION OF WORK, PROPERTY AND THE PUBLIC

a. The CM shall be responsible for the entire site and the building or construction of the same and provide all the necessary protections, as required by the Owner or designer, and by laws or ordinances governing such conditions. The CM shall be responsible for any damage to the Owner's property or of that of others on the job, by them, their personnel, or their subcontractors, and shall make good such damages. The CM shall be responsible for and pay for any damages caused to the Owner. The CM shall have access to the project at all times.

b. The CM shall be responsible to cover and protect all portions of the structure when the work is not in progress, provide and set all temporary roofs, covers for doorways, sash and windows, and all other materials necessary to protect all the work on the building. Any work damaged through the lack of proper protection or from any other cause, shall be repaired or replaced without extra cost to the Owner.

c. No fires of any kind will be allowed inside or around the operations during the course of construction without special permission from the Designer.

d. The CM shall ensure that all trees and shrubs designated to remain in the vicinity of the construction operations are protected in accordance with the requirements of the plans and specifications. All walks, roads, etc., shall be barricaded as directed by the designer to keep the public away from the construction. All trenches, excavations or other hazards in the vicinity of the work shall be well barricaded and properly lighted at night.

e. The CM shall develop and implement a project safety plan that provides all necessary safety measures for the protection of all persons on the job, including the requirements of the A.G.C. *Accident Prevention Manual in Construction*, as amended, and shall fully comply with all state laws or regulations and North Carolina State Building Code requirements to prevent accident or injury to persons on or about the location of the work. The CM shall clearly mark or post signs warning of hazards existing, and shall barricade excavations, elevator shafts, stairwells and similar hazards. The CM shall insure that protection is provided against damage or injury resulting from falling materials and that all protective devices and signs be maintained throughout the progress of the work.

f. The CM shall adhere to the rules, regulations and interpretations of the North Carolina Department of Labor relating to Occupational Safety and Health Standards for the Construction Industry (Title 29, Code of Federal Regulations, Part 1926, published in Volume 39, Number 122, Part II, June 24, 1974, *Federal Register*), and revisions thereto as adopted by N.C.G.S. 95-126 through 155.

g. The CM shall. designate a responsible person of his organization as safety officer/inspector to inspect the project site for unsafe health and safety hazards, to report these hazards to the contractor for correction, and whose duties also include accident prevention on the project, and to provide other safety and health measures on the project site as required by the terms and conditions of the contract. The name of the safety inspector shall be made known to the designer and owner at the time of the preconstruction conference and in all cases prior to any work starting on the project.

h. In the event of an emergency affecting the safety of life, the protection of work, or the safety of adjoining properties, the CM is hereby authorized to act at his own discretion, without further authorization from anyone, to prevent such threatened injury or damage. Any compensation claimed by the CM on account of such action shall be determined as provided for under Article 19(b).

i. Any and all costs associated with correcting damage caused to adjacent properties of the construction site or staging area shall be borne by the contractor. These costs shall include but not be limited to flooding, mud, sand, stone, debris, and discharging of waste products.

ARTICLE 12 - SEDIMENTATION POLLUTION CONTROL ACT OF 1973

a. Any land-disturbing activity performed by the CM or any Principal Trade or Specialty Contractor in connection with the project shall comply with all erosion control measures set

forth in the contract documents and any additional measures which may be required in order to ensure that the project is in full compliance with the Sedimentation Pollution Control Act of 1973, as implemented by Title 15, North Carolina Administrative Code, Chapter 4, Sedimentation Control, Subchapters 4A, 4B and 4C, as amended (15 N.C.A.C. 4A, 4B and 4C).

b. Upon receipt of notice that a land-disturbing activity is in violation of said act, the CM shall be responsible for ensuring that all steps or actions necessary to bring the project in compliance with said act are promptly taken.

c. The CM shall be responsible for defending any legal actions instituted pursuant to N.C.G.S. 113A-64 against any party or persons described in this article.

d. To the fullest extent permitted by law, the CM shall indemnify and hold harmless the Owner, the designer and the agents, consultants and employees of the Owner and designer, from and against all claims, damages, civil penalties, losses and expenses, including, but not limited to, attorneys' fees, arising out of or resulting from the performance of work or failure of performance of work, provided that any such claim, damage, civil penalty, loss or expense is attributable to a violation of the Sedimentation Pollution Control Act. Such obligation shall not be construed to negate, abridge or otherwise reduced any other right or obligation of indemnity which would otherwise exist as to any party or persons described in this article.

ARTICLE 13 - INSPECTION OF THE WORK

a. It is a condition of this contract that the work shall be subject to inspection during normal working hours by the designer, designated official representatives of the Owner, State Construction Office and those persons required by state law to test special work for official approval. The CM shall therefore provide safe access to the work at all times for such inspections.

b. All instructions to the CM will be made only by or through the designer or his designated project representative. Observations made by official representatives of the Owner shall be conveyed to the designer for review and coordination prior to issuance to the CM.

c. The CM shall perform quality control inspections on the work of Principal Trade and Specialty Contractors to guard the Owner against defects and deficiencies in the work and shall coordinate this activity with the on-site duties of the Project Designer. The CM shall advise the Project Designer of any apparent variation and/or deviation from the intent of the Contract Documents and shall take the necessary action to correct such variations and deviations.

d. All work shall be inspected by designer, special inspector and/or State Construction Office prior to being covered by the contractor. The CM shall give a minimum two weeks' notice unless otherwise agreed to by all parties. If inspection fails, after the first re-inspection all costs associated with additional re-inspections shall be borne by the CM.

e. Where special inspection or testing is required by virtue of any state laws, instructions of the designer, specifications or codes, the CM shall give adequate notice to the Project Designer of the time set for such inspection or test, if the inspection or test will be conducted by a party other than the Project Designer. Such special tests or inspections will be made in the presence of the Project Designer, or his authorized representative, and it shall be the CM's responsibility to serve ample notice of such tests.

f. All laboratory tests shall be paid by the Owner unless provided otherwise in the contract documents except the CM shall pay for laboratory tests to establish design mix for concrete and for additional tests to prove compliance with contract documents where materials have tested deficient except when the testing laboratory did not follow the appropriate ASTM testing procedures.

g. Should any work be covered up or concealed prior to inspection and approval by the Project Designer and/or (SCO) such work shall be uncovered or exposed for inspection, if so requested by the Project Designer or SCO in writing. Inspection of the work will be made promptly upon notice from the CM. All cost involved in uncovering, repairing, replacing, recovering and restoring to design condition, the work that has been covered or concealed will be paid by the CM.

ARTICLE 14 - CONSTRUCTION SUPERVISION AND SCHEDULE

a. On-site representatives of the CM shall manage the work of the Principal Trade and Specialty Contractors and coordinate the work with the activities of the Owner and Project Designer to complete the project with the Owner's objectives of cost, time and quality. Throughout the progress of the work, the CM shall maintain a competent and adequate full-time staff approved by the Owner and Project Designer. It is understood that the designated and approved on-site representative of the CM will remain on the job and in responsible charge as long as those persons remain employed by the CM unless otherwise requested or agreed to by the Owner. The CM shall establish an on-site organization with appropriate lines of authority to act on behalf of the CM. Instructions, directions or notices given to the designated on-site authority shall be as binding as if given to the CM. However, directions, instructions, and notices shall be confirmed in writing.

b. The CM shall examine and study the drawings and specifications and fully understand the project design, and shall provide constant and efficient supervision to the work. Should he discover any discrepancies of any sort in the drawings or specifications, he shall report them to the designer without delay. He will not be held responsible for discrepancies in the drawings and/or specifications, but shall be held responsible to report them should they become known to him.

c. The CM shall call and preside over monthly job site progress conferences. All Principal Trade and Specialty Contractors shall be represented at these job progress conferences by both home office and project personnel. The CM shall require attendance from other subcontractors and material suppliers who can contribute toward maintaining required job progress. It shall be the principal purpose of these meetings, or conferences, to effect coordination, cooperation and assistance in every practical way toward the end of maintaining progress of the project on schedule and to complete the project within the specified contract time. The CM shall be prepared to assess progress of the work and to recommend remedial measures for correction of progress as may be appropriate. The CM with assistance from the Designer shall be the coordinator of the conferences and shall preside as chairman. The CM shall turn over a copy of his daily reports to the Designer and Owner at the job site progress conference. Owner will determine daily report format.

d. The CM shall employ an engineer or a land surveyor licensed in the State of North Carolina to lay out the work and to establish a bench mark nearby in a location where same will not be disturbed and where direct instruments sights may be taken.

e. Prior to bidding, it shall be the responsibility of the CM to prepare an electronic and paper copy of a preliminary critical path method (CPM) schedule and submit such schedule to the Project Designer for his review and comment in sufficient time to allow revisions prior to inserting said schedule into the Principal Trade and Specialty Contractors' bid packages. After contract award but prior to thirty (30) days from the date of the notice to proceed, the CM shall obtain from the Principal Trade and Specialty Contractors their respective work activities and integrate them into a project construction schedule in CPM form. The resulting CPM schedule shall show all salient features of the work required for construction of the project from start to finish within the time allotted by the contract. The time in days between the CM's early completion date and the contractual completion date is project float time and shall be used as such by the CM unless amended by change order. The CM shall submit to the Project Designer an electronic and paper copy of the final CPM schedule after contracts are executed but within fifteen (15) days prior to the written notice to proceed. The Project Designer after reviewing and commenting on the project CPM schedule shall submit it to the Owner for approval. No application for payment will be processed until the project CPM schedule is approved by the Owner. No monthly application for payment will be processed without the submission of an electronic and paper copy of the CPM schedule attached.

f. The CPM schedule shall be a complete computer-generated network analysis showing the complete sequence of construction activities, identifying the work of separate stages and other logically grouped activities, indicating early and late start and early and late finish dates, float duration and a complete logic. Monthly updates will show the estimated completion of each activity.

g. The CM shall distribute to the principal trade and specialty contractors the approved project CPM schedule and shall display same at the job site.

h. The CM shall maintain the project CPM schedule, making monthly adjustments, updates, corrections, etc., which are necessary to finish the project within the time allotted by the contract. In doing so, the CM shall keep the designer as well as all Principal Trade and Specialty Contractors fully informed as to all changes and updates to the schedule. The CM shall submit to the Project Designer a monthly report of the status of all work activities. The monthly status report shall show the actual work completed to date in comparison with the original amount of work scheduled. If the work is behind schedule, the CM must indicate in writing what measures are being taken to bring the work back on schedule and ensure that the contract completion date is not exceeded. If the work is greater than thirty (30) days behind schedule and no legitimate requests for time extensions are in process, then the CM shall prepare and submit to the Project Designer a recovery schedule for review and approval. Failure of the CM to abide by the directives in this paragraph will give the Owner cause to exercise the remedies set forth in Article 29 of the General Conditions and pursue any other legal remedies allowed it by law.

ARTICLE 15 – {NOT USED}

ARTICLE 16 - PRINCIPAL TRADE AND SPECIALTY CONTRACTS AND CONTRACTORS

a. Principal Trade and Specialty Contractors shall be pre-qualified by the CM. The prequalification criteria shall be determined by the Owner and CM to address quality, performance, the time specified in the bids for performance of the contract, the cost of construction oversight, time for completion, capacity to perform, and any other factors deemed appropriate by the Owner and/or CM. Basic qualification information from Principal Trade and Specialty Contractors shall be requested on the standard State of North Carolina

Prequalification Form approved by the State Building Commission. Only pre-qualified contractors are allowed to bid to and contract with the CM on a project.

b. All bids for Principal Trade and Specialty Contracts shall be publicly advertised and shall be opened publicly in a public venue, and once opened, shall be public records under N.C.G.S. 132. The CM shall award the contract to the lowest responsible, responsive bidder, taking into consideration quality, performance, the time specified in the bids for performance of the contract, the time for completion, compliance with N.C.G.S. 143-128.2, and other factors deemed appropriate by the Owner and advertised as part of the bid solicitation. When contracts are awarded pursuant to this section, the Owner shall provide for a dispute resolution procedure as provided by N.C.G.S. 143-128(f1). Once Principal Trade and Specialty Contractors are in place, the CM shall provide copies of the contracts to the Project Designer and also provide a list of equipment and material suppliers.

c. A CM may perform a portion of the work only if (a) bidding produces no responsible, responsive bidder for that portion of the work, or (b) the lowest responsible, responsive bidder will not execute a contract for the bid portion of the work, or the Principal Trade or Specialty Contractor defaults and a prequalified replacement cannot be obtained in a timely manner, and (c) the Owner approves performance of the work by the CM.

d. The Designer will furnish to any Principal Trade or Specialty Contractor, upon request, evidence regarding amounts of money paid to the CM on account of the work of the Principal Trade or Specialty Contractor.

e. The CM is and remains fully responsible for his own acts or omissions as well as those of any Principal Trade or Specialty Contractor or of any employee of either. The CM agrees that no contractual relationship exists between the Principal Trade and Specialty Contractors and the Owner in regard to the contract, and that the Principal Trade and Specialty Contractors act on this work as an agent or employee of the CM.

ARTICLE 17 - CONSTRUCTION MANAGER AND SUBCONTRACTOR RELATIONSHIPS

The CM agrees that the terms of these contract documents shall apply equally to each Principal Trade and Specialty Contractor as to the CM, and the CM agrees to take such action as may be necessary to bind each Principal Trade and Specialty Contractor to these terms. The CM further agrees to conform to the Code of Ethical Conduct as adopted by the Associated General Contractors of America, Inc., with respect to CM-subcontractor relationships, and that payments to Principal Trade and Specialty Contractors shall be made in accordance with the provisions of N.C.G.S. 143-134.1 titled “Interest on final payments due to prime contractors: payments to subcontractors”.

a. On all public construction contracts which are let by a board or governing body of the state government or any political subdivision thereof, except contracts let by the Department of Transportation pursuant to N.C. G.S. 136-28.1, the balance due the CM shall be paid in full within 45 days after respective prime contracts of the project have been accepted by the Owner, certified by the architect, engineer or designer to be completed in accordance with terms of the plans and specifications, or occupied by the Owner and used for the purpose for which the project was constructed, whichever occurs first. Provided, however, that whenever the architect or consulting engineer in charge of the project determines that delay in completion of the project in accordance with terms of the plans and specifications is the fault of the CM, the project may be occupied and used for the purposes for which it was constructed without payment of any interest on amounts withheld past the 45 day limit. Should final

payment to the CM beyond the date such contracts have been certified to be completed by the Project Designer, accepted by the Owner, or occupied by the Owner and used for the purposes for which the project was constructed, be delayed by more than 45 days, said CM shall be paid interest, beginning on the 46th day, at the rate of one percent (1%) per month or fraction thereof unless a lower rate is agreed upon on such unpaid balance as may be due. In addition to the above final payment provisions, periodic payments due the CM during construction shall be paid in accordance with the payment provisions of the contract documents or said CM shall be paid interest on any such unpaid amount at the rate stipulated above for delayed final payments. Such interest shall begin on the date the payment is due and continue until the date on which payment is made. Such due date may be established by the terms of the contract. Funds for payment of such interest on state-owned projects shall be obtained from the current budget of the owning department, institution or agency. Where a conditional acceptance of a contract exists, and where the Owner is retaining a reasonable sum pending correction of such conditions, interest on such reasonable sum shall not apply.

b. Within seven days of receipt by the CM of each periodic or final payment, the CM shall pay the Principal Trade and Specialty Contractors based on work completed or service provided under their contract with the CM. Should any periodic or final payment to a Principal Trade or Specialty Contractor be delayed by more than seven days after receipt of periodic or final payment by the CM, the CM shall pay the Principal Trade or Specialty Contractor interest, beginning on the eighth day, at the rate of one percent (1%) per month or fraction thereof on such unpaid balance as may be due.

c. The percentage of retainage on payments made by the CM to the Principal Trade and Specialty Contractors shall not exceed the percentage of retainage on payments made by the Owner to the CM. Any percentage of retainage on payments made by the CM to the Principal Trade or Specialty Contractors that exceeds the percentage of retainage on payments made by the Owner to the CM shall be subject to interest to be paid by the CM to the Principal Trade or Specialty Contractor at the rate of one percent (1%) per month or fraction thereof.

d. Nothing in this section shall prevent the CM at the time of application and certification to the Owner from withholding application and certification to the Owner for payment to a Principal Trade or Specialty Contractor for unsatisfactory job progress; defective construction not remedied; disputed work; third-party claims filed or reasonable evidence that claim will be filed; failure of the Principal Trade or Specialty Contractor to make timely payments for labor, equipment and materials; damage to CM or another subcontractor; reasonable evidence that a Principal Trade or Specialty Contract cannot be completed for the unpaid balance of the subcontract sum; or a reasonable amount for retainage not to exceed the initial percentage retained by Owner.

ARTICLE 18 - DESIGNER'S STATUS

a. The Project Designer shall provide liaison and necessary inspection of the work to ensure compliance with plans and specifications. He is the agent of the Owner only for the purpose of constructing this work and to the extent stipulated in the contract documents. He has authority to stop work or to order work removed, or to order corrections of faulty work where such action may be necessary to assure successful completion of the work.

b. The Project Designer is the impartial interpreter of the contract documents, and, as such, he shall exercise his powers under the contract to enforce faithful performance by both the Owner and the CM, taking sides with neither.

c. Should the Project Designer cease to be employed on the work for any reason whatsoever, then the Owner shall employ a competent replacement who shall assume the status of the former Project Designer.

d. The Project Designer will make periodic inspections of the project at intervals appropriate to the stage of construction. He will inspect the progress, the quality and the quantity of the work.

e. The Project Designer and the Owner shall have access to the work whenever it is in preparation and progress during normal working hours. The CM shall provide facilities for such access so the Designer may perform his functions under the contract documents.

f. Based on the Project Designer's inspections and evaluations of the project, the Project Designer shall issue interpretations, directives and decisions as may be necessary to assist the CM in the administration of the project. His decisions relating to artistic effect and technical matters shall be final, provided such decisions are within the limitations of the contract. The CM's decisions, however, relating to means and methods, and administration of the contracts the CM holds are final.

ARTICLE 19 - CHANGES IN THE WORK

a. The Owner may have changes made in the work covered by the contract. These changes will not invalidate and will not relieve or release the CM from any guarantee given by him pertinent to the contract provisions. These changes will not affect the validity of the guarantee bond and will not relieve the surety or sureties of said bond. All extra work shall be executed under conditions of the original contract.

b. Except in an emergency endangering life or property, no change shall be made by the contractor except upon receipt of approved change order or written field order from the designer, countersigned by the owner and the state construction office authorizing such change. No claim for adjustments of the contract price shall be valid unless this procedure is followed.

A field order, transmitted by fax or hand- delivered, may be used where the change involved impacts the critical path of the work. A formal change order shall be issued as expeditiously as possible.

The CM may be requested to make a change to the work by the Project Designer and Owner where such work is to be funded by the CM Contingency or Project Reserve that is part of the GMP contract. Such a change must be documented in the same manner as a Change Order and must be authorized in writing by the Project Designer and Owner by a Field Change document.

In the event of emergency endangering life or property, the CM may be directed to proceed on a time and material basis whereupon the CM shall proceed and keep accurately on such form as may be required, a correct account of costs together with all proper invoices, payrolls and supporting data. Upon completion of the work the change order will be prepared as outlined under either Method "c(1)" or Method "c(2)" or both.

c. In determining the values of changes, either additive or deductive, the CM and Principal Trade and Specialty Contractors are restricted to the use of the following methods:

1. Where the extra work involved is covered by unit prices quoted in the proposal, the value of the change shall be computed by application of unit prices based on quantities,

estimated or actual as agreed of the items involved, except is such cases where a quantity exceeds the estimated quantity allowance in the contract by one hundred percent (100%) or more. In such cases, either party may elect to proceed under subparagraph c2 herein. If neither party elects to proceed under c2, then unit prices shall apply.

2. The contracting parties shall negotiate and agree upon the equitable value of the change prior to issuance of the change order, and the change order shall stipulate the corresponding lump sum adjustment to the contract price.

d. Under Paragraph “b” and Methods "c(2)" above, the allowances for overhead and profit combined for a Principal Trade or Specialty Contractor and all multi-tier subcontractors shall not exceed fifteen percent (15%) of **net cost** of the work. No allowance for overhead and profit will be allowed for the CM until the change orders aggregate to a sum in excess of five percent (5%) of the Cost of the Work portion of the GMP. Once this threshold is met the CM may add an overhead & profit allowance not to exceed four percent (4%) of the net cost of the change order. Change orders to the GMP which authorize additional phases of a project without a change in scope of the originally intended project will not be considered in establishing the threshold for additional CM overhead & profit. Under Method "c (1)", no additional allowances shall be made for overhead and profit. In the case of deductible change orders, under Method "c(2)" and Paragraph (b) above, the contractor shall include no less than five percent (5%***)*** profit, but no allowances for overhead.

e. The term "net cost" as used herein shall mean the difference between all proper cost additions and deductions. The "cost" as used herein shall be limited to the following:

1. The actual costs of materials and supplies incorporated or consumed as part of the project;

2. The actual costs of labor expended on the project site;

3. The actual costs of labor burden, limited to the costs of social security (FICA) and Medicare/Medicaid taxes; unemployment insurance costs; health/dental/vision insurance premiums; paid employee leave for holidays, vacation, sick leave, and/or petty leave, not to exceed a total of 30 days per year; retirement contributions; worker’s compensation insurance premiums; and the costs of general liability insurance when premiums are computed based on payroll amounts; the total of which shall not exceed thirty percent (30%) of the actual costs of labor;

4. The actual costs of rental for tools, excluding hand tools; equipment; machinery; and temporary facilities required for the project;

5. The actual costs of premiums for bonds, insurance, permit fees and sales or use taxes related to the project.

Overtime and extra pay for holidays and weekends may be a cost item only to the extent approved by the Owner.

f. Should concealed conditions be encountered in the performance of the work below grade, or should concealed or unknown conditions in an existing structure be at variance with the conditions indicated by the contract documents, the contract sum and time for completion may be equitably adjusted by change order upon claim by either party made within thirty (30) days after the condition has been identified. The cost of such change shall be arrived at by one of the foregoing methods.

All change orders shall be supported by a breakdown showing method of arriving at net cost as defined above.

g. In all change orders, the procedure will be for the Project Designer to request proposals for the change order work in writing. The CM will require the Principal Trade and Specialty Contractors to provide such proposals and supporting data in suitable format and will review and approve such change orders prior to submission to the designer. The Project Designer shall verify correctness. Within fourteen (14) days after receipt of the CM's proposal**,** the Project Designer shall prepare the change order and forward to the CM for his signature or otherwise respond, in writing, to the CM's proposal. Within seven (7) days after receipt of the change order executed by the CM, the Project Designer shall, certify the change order by his signature, and forward the change order and all supporting data to the Owner for the Owner's signature. The Owner shall execute the change order and forward to the State Construction Office for final approval**,** within seven (7) days of receipt. The State Construction Office shall act on the change order within seven (7) days. Upon approval by the State Construction Office, one copy remains with the State Construction Office, and the remaining copies are sent to the Project Designer for distribution to the Owner(s)**,** CM and the surety. In case of emergency or extenuating circumstances, approval of changes may be obtained verbally by telephone or field orders approved by all parties, then shall be substantiated in writing as outlined under normal procedure.

h. At the time of signing a change order, the CM shall be required to certify as follows:

"I certify that my bonding company will be notified forthwith that my contract has been changed by the amount of this change order, and that a copy of the approved change order will be mailed upon receipt by me to my surety."

i. A change order, when issued, shall be full compensation, or credit, for the work included, omitted or substituted. It shall show on its face the adjustment in time for completion of the project as a result of the change in the work.

j. If, during the progress of the work, the Owner requests a change order and the CM's terms are unacceptable, the Owner**,** with the approval of the State Construction Office, may require the CM to perform such work on a time and material basis in accordance with paragraph "b" above. Without prejudice, nothing in this paragraph shall preclude the Owner from performing or to have performed that portion of the work requested in the change order.

ARTICLE 20 - CLAIMS FOR EXTRA COST

a. Should the CM consider that as a result of any instructions given in any form by the designer, he is entitled to extra cost above that stated in the contract, he shall give written notice thereof to the designer within seven (7) days without delay. The written notice shall clearly state that a claim for extra cost is being made and shall provide a detailed justification for the extra cost. The CM shall not proceed with the work affected until further advised, except in emergency involving the safety of life or property, which condition is covered in Article 19(b) and Article 11(h). No claims for extra compensation will be considered unless the claim is so made. The Designer shall render a written decision within seven (7) days of receipt of claim.

b. The CM shall not act on instructions received by him from persons other than the Project Designer, and any claims for extra compensation or extension of time on account of such instruction will not be honored. The Project Designer will not be responsible for misunderstandings claimed by the CM of verbal instructions which have not been confirmed in writing, and in no case shall instructions be interpreted as permitting a departure from the

contract documents unless such instruction is confirmed in writing and supported by a properly authorized change order.

c. Should a claim for extra compensation that complies with the requirements of (a) above by the CM be denied by the Project Designer or Owner, and cannot be resolved by a representative of the State Construction Office, the CM may request a mediation in connection with N.C.G.S. 143-128(f1) in the dispute resolution rules adopted by the State Building Commission (1 N.C.A.C. 30H .0101 through .1001). If the CM is unable to resolve its claims as a result of mediation, then the CM may pursue his claim in accordance with the provisions of N.C.G.S. 143-135.3, or G.S. 143-135.6 where Community Colleges are the owner, and the following:

1. A CM who has not completed a contract with a state agency or institution for construction or repair work and who has not received the amount he claims is due under the contract may submit a verified written claim to the Director of the State Construction Office of the Department of Administration for the amount the CM claims is due. The Director may deny, allow or compromise the claim, in whole or in part. A claim under this subsection is not a contested case under N.C.G.S. Chapter 150B.

2. (a) A CM who has completed a contract with a State agency or institution for construction or repair work and who has not received the amount he claims is due under the contract may submit a verified written claim to the Director of the State Construction Office of the Department of Administration for the amount the CM claims is due. The claim shall be submitted within sixty (60) days after the CM receives a final statement of the board's disposition of his claim and shall state the factual basis for the claim.

(b) The Director shall investigate a submitted claim within ninety (90) days of receiving the claim, or within any longer time period upon which the Director and the CM agree. The CM may appear before the Director, either in person or through counsel, to present facts and arguments in support of his claim. The Director may allow, deny or compromise the claim, in whole or in part. The Director shall give the CM a written statement of the Director's decision on the CM’s claim.

(c) A CM who is dissatisfied with the Director's decision on a claim submitted under this subsection may commence a contested case on the claim under Chapter 150B of the General Statutes. The contested case shall be commenced within sixty (60) days of receiving the Director's written statement of the decision.

(d) As to any portion of a claim that is denied by the Director, the CM may, in lieu of the procedures set forth in the preceding subsection of this section, within six (6) months of receipt of the Director's final decision, institute a civil action for the sum he claims to be entitled to under the contract by filing a verified complaint and the issuance of a summons in the Superior Court of Wake County or in the superior court of any county where the work under the contract was performed. The procedure shall be the same as in all civil actions except that all issues shall be tried by the judge, without a jury.

ARTICLE 21 - MINOR CHANGES IN THE WORK

The Project Designer will have the authority to order minor changes in the work not involving an adjustment in the contract sum or time for completion, and not inconsistent with the intent of the contract documents. Such changes shall be affected by written order, copied to the State Construction Office, and shall be binding on the Owner and the CM.

ARTICLE 22 - UNCORRECTED FAULTY WORK

Should the correction of faulty or damaged work be considered inadvisable or inexpedient by the Owner and the Project Designer, the Owner shall be reimbursed by the CM. A change order will be issued to reflect a reduction in the contract sum.

ARTICLE 23 - TIME OF COMPLETION, DELAYS, EXTENSION OF TIME

a. The final completion date will be as determined by the Owner, Designer and CM during the pre-construction phase of the project and will be incorporated into the contract for construction services between the Owner and the CM.

b. The CM shall commence work to be performed under this agreement on a date to be specified in a written Notice to Proceed from the Project Designer and shall fully complete all work hereunder within the time of completion specified. For each day in excess of the above number of days, the CM shall pay the Owner the sum stated as liquidated damages reasonably estimated in advance to cover the loses to be incurred by the Owner by reason of failure of the CM to complete the work within the time specified, such time being in the essence of this contract and a material consideration thereof. Should the work be delayed by both the owner and contractor, liquidated damages shall be apportioned to reflect the delays of each party. In the case of concurrent delays, contractor caused delays shall be accounted for before owner and designer caused delays.

c. If the CM is delayed at any time in the progress of his work by any act or negligence of the Owner or the Project Designer, or by any employee of either; by changes ordered in the work; by labor disputes at the project site; by abnormal weather conditions not reasonably anticipated for the locality where the work is performed; by unavoidable casualties; by any causes beyond the contractor's control; or by any other causes which the designer and Owner determine may justify the delay, then the contract time may be extended by change order for the time which the designer and Owner may determine is reasonable.

   Time extensions will not be granted for rain, wind, snow or other natural phenomena of normal intensity for the locality where work is performed. For purpose of determining extent of delay attributable to unusual weather phenomena, a determination shall be made by comparing the weather for the contract period involved with the average of the preceding five (5) year climatic range during the same time interval based on the National Oceanic and Atmospheric Administration National Weather Service statistics for the locality where work is performed and on daily weather logs kept on the job site by the CM reflecting the effect of the weather on progress of the work and initialed by the designer's representative. No weather delays shall be considered after the building is dried in unless work claimed to be delayed is on the critical path of the baseline schedule or approved updated schedule. Time extensions for weather delays, acts of God, labor disputes, fire, delays in transportation, unavoidable casualties or other delays which are beyond the control of the Owner do not entitle the Contractor to compensable damages for delays. Any contractor claim for compensable damages for delays is limited to delays caused solely by the owner or its agents. Contractor caused delays shall be accounted for before owner or designer caused delays in the case of concurrent delays.

d. Request for extension of time shall be made in writing to the designer, copies to the owner and SCO, within twenty (20) days following cause of delay. In case of continuing cause for delay, the CM shall notify the designer copies to the owner and SCO, of the delay within twenty (20) days of the beginning of the delay and only one claim is necessary.

e. The CM shall notify his surety in writing of extension of time granted.

f. No claim shall be allowed on account of failure of the Project Designer to furnish drawings or instructions until twenty (20) days after demand for such drawings and/or instructions. See Article 5c. Demand must be in written form clearly stating the potential for delay unless the drawings or instructions are provided. Any delay granted will begin after the twenty (20) day demand period is concluded.

ARTICLE 24 - PARTIAL UTILIZATION/BENEFICIAL OCCUPANCY

a. The Owner may desire to occupy or utilize all or a portion of the project when the work is substantially complete.

b. Should the owner request a utilization of a building or portion thereof, the designer shall perform a designer final inspection of area after being notified by the contractor that the area is ready for such. After the contractor has completed designer final inspection punch list and the designer has verified, then the designer shall schedule a beneficial occupancy inspection at a time and date acceptable to the owner, contractor(s) and State Construction Office. If beneficial occupancy is granted by the State Construction Office, in such areas the following will be established:

1. The beginning of guarantees and warranties period for the equipment necessary to support. in the area.

2. The owner assumes all responsibilities for utility costs for entire building.

3. Contractor will obtain consent of surety.

4. Contractor will obtain endorsement from insurance company permitting beneficial occupancy.

c. The Owner shall have the right to exclude the CM from any part of the project which the Project Designer has so certified to be substantially complete, but the Owner will allow the CM reasonable access to complete or correct work to bring it into compliance with the contract.

d. Occupancy by the Owner under this article will in no way relieve the CM from his contractual requirement to complete the project within the specified time. The contractor will not be relieved of liquidated damages because of beneficial occupancy. The designer may prorate liquidated damages based on the percentage of project occupied.

ARTICLE 25 - FINAL INSPECTION, ACCEPTANCE, AND PROJECT CLOSEOUT

a. Upon notification from the CM that the project is complete and ready for inspection, the Project Designer shall make a designer final inspection to verify that the project is complete and ready for SCO final inspection. Prior to SCO final inspection, the CM shall ensure that all items requiring corrective measures noted at the designer final inspection are complete.

The Project Designer shall schedule an SCO final inspection at a time and date acceptable to the Owner, the CM and the State Construction Office.

b. At the SCO final inspection, the designer and his consultants shall, if job conditions warrant, record a list of items that are found to be incomplete or not in accordance with the contract documents. At the conclusion of the SCO final inspection, the designer and State Construction Office representative shall make the following determinations:

   1. That the project is completed and accepted.

   2. That the project is accepted subject to the correction of the list of discrepancies (punch list). All punch list items must be completed within thirty (30) days of SCo final inspection or the Owner may invoke Article 28, Owner's Right to Do Work.

   3. That the project is not complete and another date for a final inspection will be established.

c. Within fourteen (14) days of acceptance per Paragraph c1 or within fourteen (14) days after completion of punch list per Paragraph c2 above, the Project Designer shall certify the work and issue applicable certificate(s) of compliance.

d. Any discrepancies listed or discovered after the date of SCO final inspection and acceptance under Paragraphs c1 or c2 above shall be handled in accordance with Article 42.

e. The date of acceptance will establish the following:

   1. The beginning of guarantees and warranties period.

   2. The date on which the CM's insurance coverage for public liability, property damage and builder's risk may be terminated.

   3. That no liquidated damages (if applicable) shall be assessed after this date.

   4. The termination date of utility cost to the CM (if applicable).

f. **Prior to issuance of final acceptance date, the contractor shall have his authorized representatives visit the project and give full instructions to the designated personnel regarding operating, maintenance, care, and adjustment of all equipment and special construction elements. In addition, the contractor shall provide to the owner a complete instructional video (media format acceptable to the owner) on the operation, maintenance, care and adjustment of all equipment and special construction elements.**

ARTICLE 26 - CORRECTION OF WORK BEFORE FINAL PAYMENT

a. Any work, materials, fabricated items or other parts of the work which have been condemned or declared not in accordance with the contract by the designer shall be promptly removed from the work site by the CM, and shall be immediately replaced by new work in accordance with the contract at no additional cost to the Owner. Work or property of the Owner, damaged or destroyed by virtue of such faulty work, shall be made good at the expense of the CM.

b. Correction of condemned work described above shall commence within twenty-four (24) hours after receipt of notice from the Project Designer, and shall make satisfactory progress until completed.

c. Should the CM fail to proceed with the required corrections, then the Owner may complete the work in accordance with the provisions of Article 28.

ARTICLE 27 - CORRECTION OF WORK AFTER FINAL PAYMENT

See Article 35, Performance Bond and Payment Bond, and Article 42, Guarantee**.** Neither the final certificate, final payment, occupancy of the premises by the Owner, nor any provision of the contract, nor any other act or instrument of the Owner, nor the Project Designer, shall relieve the CM from responsibility for negligence, or faulty material or workmanship, or failure to comply with the drawings and specifications. The CM shall correct or make good any defects due thereto and repair any damage resulting therefrom, which may appear during the guarantee period following final acceptance of the work except as stated otherwise under Article 42, Guarantee. The Owner will report any defects as they may appear to the CM and establish a time limit for completion of corrections by the CM. The Owner will be the judge as to the responsibility for correction of defects.

ARTICLE 28 - OWNER'S RIGHT TO DO WORK

If, during the progress of the work or during the period of guarantee, the CM fails to prosecute the work properly or to perform any provision of the contract, the Owner, after seven (7) days written notice sent by certified mail, return receipt requested, to the CM from the designer, may perform or have performed that portion of the work. The cost of the work may be deducted from any amounts due or to become due to the CM, such action and cost of same having been first approved by the Project Designer. Should the cost of such action of the Owner exceed the amount due or to become due the CM, then the CM or his surety, or both, shall be liable for and shall pay to the Owner the amount of said excess.

ARTICLE 29 - ANNULMENT OF CONTRACT

If the CM fails to begin the work under the contract within the time specified or fails to establish a GMP or obtain bids from or enter into contracts with qualified Principal Trade or Specialty Contractors within the GMP, or the progress of the work is not maintained on schedule, or the work is not completed within the time above specified, or fails to perform the work with sufficient workmen and equipment or with sufficient materials to ensure the prompt completion of said work, or shall perform the work unsuitably or shall discontinue the prosecution of the work, or if the CM shall become insolvent or be declared bankrupt or commit any act of bankruptcy or insolvency, or allow any final judgment to stand against him unsatisfied for a period of forty-eight (48) hours, or shall make an assignment for the benefit of creditors, or for any other cause whatsoever shall not carry on the work in an acceptable manner, the Owner may give notice in writing, sent by certified mail, return receipt requested, to the CM and his surety of such delay, neglect or default, specifying the same, and if the CM within a period of seven(7) days after such notice shall not proceed in accordance therewith, then the Owner shall, declare this contract in default, and, thereupon, the surety shall promptly take over the work and complete the performance of this contract in the manner and within the time frame specified. In the event the surety shall fail to take over the work to be done under this contract within seven(7) days after being so notified and notify the Owner in writing, sent by certified mail, return receipt requested, that he is taking the same over and stating that he will diligently pursue and complete the same, the Owner shall have full power and authority, without violating the contract, to take the prosecution of the work out of the hands of said CM, to appropriate or use any or all contract materials and equipment on the grounds as may be suitable and acceptable and may enter into an agreement, either by public letting or negotiation, for the completion of said contract according to the terms and provisions thereof or use such other methods as in his opinion shall be required for the completion of said contract in an acceptable manner. All costs and charges incurred by the Owner, together with the costs of completing the

work under contract, shall be deducted from any monies due or which may become due said CM and surety. In case the expense so incurred by the Owner shall be less than the sum which would have been payable under the contract, if it had been completed by said CM, then the said CM and surety shall be entitled to receive the difference, but in case such expense shall exceed the sum which would have been payable under the contract, then the CM and the surety shall be liable and shall pay to the Owner the amount of said excess.

ARTICLE 30 – CONSTRUCTION MANAGER'S RIGHT TO STOP WORK OR TERMINATE THE CONTRACT

a. Should the work be stopped by order of a court having jurisdiction, or by order of any other public authority for a period of three months, due to cause beyond the fault or control of the CM, or if the Owner should fail or refuse to make payment on account of a certificate issued by the designer within forty-five (45) days after receipt of same, then the CM, after fifteen (15) days' written notice sent by certified mail, return receipt requested, to the Owner and the designer, may suspend operations on the work or terminate the contract.

b. The Owner shall be liable to the CM for the cost of all materials delivered and work performed on this contract plus ten (10) percent overhead and profit and shall make such payment. The designer shall be the judge as to the correctness of such payment.

ARTICLE 31 - REQUEST FOR PAYMENT

a. Not later than the fifth day of the month, the CM shall submit to the designer a request for payment for work done during the previous month. The request shall be in the form agreed upon between the CM and the designer, but shall show substantially the value of work done and materials delivered to the site during the period since the last payment, and shall sum up the financial status of the contract with the following information:

1. Total of contract including change orders.

2. Value of work completed to date.

3. Less five percent (5%) retainage, provided however, that after fifty percent (50%) of the CM's work has been satisfactorily completed on schedule, with approval of the owner and the State Construction Office and written consent of the surety, further requirements for retainage will be waived only so long as work continues to be completed satisfactorily and on schedule.

4. Less previous payments.

5. Current amount due.

b. Prior to submitting the first payment request, the CM shall prepare a schedule showing a breakdown of the contract price into values of the various parts of the GMP contract. The Cost of the Work breakdown will be arranged so as to facilitate payments to the Principal Trade and Specialty Contractors in accordance with Article 17. The combined CM Construction Management Fee, Bonds & Insurance, CM Contingency, and Project Reserve (if any) will be shown on the Schedule of values as separate lines. The values for the CM Contingency and Project Reserve (if any) will move to appropriate lines within the Cost of the Work as those funds are committed and expended. This schedule of values will be submitted to & approved by the designer and Owner within 30 days of the Notice to Proceed.

The schedule of values shall be prepared in such form and supported by such data to substantiate its accuracy as the designer and Owner may require.

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c. Applications for payment shall be in a form agreed upon by the CM, designer and Owner and shall prepared and supported by such data to substantiate the accuracy of the request as the designer may require.

d. Subject to other provisions of the contract documents, the amount of each progress payment shall be computed as follows:

1. Take that portion of the GMP properly allocable to completed work as determined by multiplying the percentage completion of each portion Cost of the Work by the share of the GMP allocated to that portion of the work in the schedule of values.

2. Add that portion of the GMP properly allocable to materials and equipment delivered and suitably stored at the site for subsequent incorporation in the work or if approved in advance by the Owner, suitably stored off site at a location agreed upon in writing.

3. Subtract the aggregate of previous payments made by the Owner.

4. Subtract the amount, in any, by which the CM has been previously overpaid, as evidenced by the Owner's review of the CM's documentation.

5. Subtract amounts, if any, for which the Project Designer has withheld or nullified a certificate of payment.

6. Subtract retainage as per paragraph (h) below.

7. Add the amount due for the CM Construction Management Fee calculated on the basis the percentage completion of the project or on a schedule of payment negotiated with the Owner less fifteen percent (15%) and less previous payments for CM Construction Management Fee.

e. Payment allocated to Principal Trade and Specialty Contractors shall be subject to five percent (5%) retainage, provided, however that after fifty percent (50%) of the Cost of the Work has been satisfactorily completed on schedule, with the approval of the Owner and the State Construction Office and with written consent of the surety, further requirements for retainage will be waived only so long as work continues to be completed satisfactorily and on schedule. The balance of the CM Construction Management Fee shall be held by the Owner until satisfactory completion and close out of the project. Satisfactory completion and close out of the project is understood to mean that the Owner and Project Designer are satisfied that the project has been completed in accordance with the plans and specifications and within the GMP, all general conditions of the contract pertaining to close out have been satisfied, and all Principal Trade and Specialty Contractors have satisfactorily completed their respective contracts. No retainage will be held for the cost of Bonds and Insurance

f. When payment is made on account of stored materials and equipment, such materials must be stored on the owner's property, and the requests for payments shall be accompanied by invoices or bills of sale or other evidence to establish the owner's title to such materials and equipment. Such payments will be made only for materials that have been customized or fabricated specifically for this project. Raw materials or commodity products including but not limited to piping, conduit, CMU, metal studs and gypsum board may not be submitted. Responsibility for such stored materials and equipment shall remain with the CM regardless

of ownership title. Such stored materials and equipment shall not be removed from the owner's property. Should the space for storage on-site be limited, the CM, at his option, shall be permitted to store such materials and/or equipment in a suitable space off-site. Should the CM desire to include any such materials or equipment in his application for payment, they must be stored in the name of the owner in an independent, licensed, bonded warehouse approved by the designer, owner and the State Construction Office and located as close to the site as possible. The warehouse selected must be approved by the CM's bonding and insurance companies; the material to be paid for shall be assigned to the owner and shall be inspected by the designer. Upon approval by the designer, owner and SCO of the storage facilities and materials and equipment, payment therefore will be certified. Responsibility for such stored materials and equipment shall remain with the CM. Such stored materials and equipment shall not be moved except for transportation to the project site. Under certain conditions, the designer may approve storage of materials at the point of manufacture, which conditions shall be approved by the designer, the owner and the State Construction Office prior to approval for the storage and shall include an agreement by the storing party which unconditionally gives the State absolute right to possession of the materials at any time. Bond, security and insurance protection shall continue to be the responsibility of the CM.

g. In the event of beneficial occupancy, retainage of funds due the CM may be reduced with the approval of the State Construction Office to an equitable amount to cover the list of items to be completed or corrected. Retainage may not be reduced to less than two and one-half (2 1/2) times the estimated value of the work to be completed or corrected. Reduction of retainage must be with the consent and approval of the CM's bonding company.

ARTICLE 32 - CERTIFICATES OF PAYMENT AND FINAL PAYMENT

a. Within five (5) days from receipt of request for payment from the CM, the designer shall issue and forward to the Owner a certificate for payment. This certificate shall indicate the amount requested or as approved by the designer. If the certificate is not approved by the designer, he shall state in writing to the CM and the Owner his reasons for withholding payment.

b. No certificate issued or payment made shall constitute an acceptance of the work or any part thereof. The making and acceptance of final payment shall constitute a waiver of all claims by the Owner except:

1. Claims arising from unsettled liens or claims against the CM.

2. Faulty work or materials appearing after final payment.

3. Failure of the contractor to perform the work in accordance with drawings and specifications, such failure appearing after payment.

4. As conditioned in the performance bond and payment bond.

c. The making and acceptance of final payment shall constitute a waiver of all claims by the CM except those claims previously made and remaining unsettled (Article 20(c)).

d. Prior to submitting request for final payment to the designer for approval, the CM shall fully comply with all requirements specified in the “project closeout” section of the specifications. These requirements include but not limited to the following:

1. Submittal of Product and Operating Manuals, Warranties and Bonds, Guarantees, Maintenance Agreements, As-Built Drawings, Certificates of Inspection or Approval

from agencies having jurisdiction. (The designer must approve the Manuals prior to delivery to the Owner).

2. Transfer of required attic stock material and all keys in an organized manner.

3. Record of Owner's training.

4. Resolution of any final inspection discrepancies.

5. Granting access to Contractor's records, if Owner's internal auditors have made a request for such access pursuant to Article 52.

e. The CM shall forward to the designer, the final application for payment along with the following documents:

1. List of minority business subcontractors and material suppliers showing breakdown of contracts amounts and total actual payments to subcontractors and material suppliers.

2. Affidavit of Release of Liens.

3. Affidavit from CM of payment to material suppliers and subcontractors. (See Article 36).

4. Consent of Surety to Final Payment**.**

5. Certificates of state agencies required by state law.

f. The designer will not authorize final payment until the work under contract has been certified by Project Designer, certificates of compliance issued, and the CM has complied with the closeout requirements. The designer shall forward the CM's final application for payment to the Owner along with respective certificate(s) of compliance required by law.

ARTICLE 33 - PAYMENTS WITHHELD

a. The designer with the approval of the State Construction Office may withhold payment for the following reasons:

1. Faulty work not corrected.

2. The unpaid balance on the contract is insufficient to complete the work in the judgment of the designer.

3. To provide for sufficient contract balance to cover liquidated damages that will be assessed against the CM.

b. The Secretary of the Department of Administration may authorize the withholding of payment for the following reasons:

1. Claims filed against the CM or evidence that a claim will be filed.

2. Evidence that Principal Trade or Specialty Contractors have not been paid.

c. The Owner may withhold all or a portion of CM's Project Management Fee costs set forth in the approved schedule of values, if CM has failed to comply with: (1) a request to access its records by Owner's internal auditors pursuant to Article 52; (2) a request for a plan of action and/or recovery schedule under Article 14.j or provide The Owner; (3) a request to provide an electronic copies of Contractor's baseline schedule, updates with all logic used to create the schedules in the original format of the scheduling software; and (4) Contractor's failure to have its Superintendent on the Project full-time.

d. When grounds for withholding payments have been removed, payment will be released. Delay of payment due the CM without cause will make owner liable for payment of interest to the CM in accordance with G.S. 143-134.1. As provided in G.S.143-134.1(e) the owner shall not be liable for interest on payments withheld by the owner for unsatisfactory job progress, defective construction not remedied, disputed work, or third-party claims filed against the owner or reasonable evidence that a third-party claim will be filed.

ARTICLE 34 - MINIMUM INSURANCE REQUIREMENTS

The work under this contract shall not commence until the CM has verified to the Owner that all required insurance and verifying certificates of insurance have been obtained and approved in writing by the Owner. These certificates shall contain a provision that coverages afforded under the policies will not be cancelled, reduced in amount or coverages eliminated until at least thirty (30) days after mailing written notice, by certified mail, return receipt requested, to the insured and the Owner of such alteration or cancellation.

a. **Worker's Compensation and Employer's Liability**

The CM shall ensure that it and all Principal Trade and Specialty Contractors shall provide and maintain, during the life of the contract, workmen's compensation insurance, as required by law, as well as employer's liability coverage with minimum limits of $100,000.

b. **Public Liability and Property Damage**

The CM shall ensure that it and all Principal Trade and Specialty Contractors shall provide and maintain, during the life of the contract, comprehensive general liability insurance, including coverage for premises operations, independent contractors, completed operations, products and contractual exposures, as shall protect such contractors from claims arising out of any bodily injury, including accidental death, as well as from claims for property damages which may arise from operations under this contract, whether such operations be by the contractor or by any subcontractor, or by anyone directly or indirectly employed by either of them and the minimum limits of such insurance shall be as follows:

Bodily Injury:	$500,000 per occurrence
Property Damage:	$100,000 per occurrence / $300,000 aggregate

In lieu of limits listed above, a $500,000 combined single limit shall satisfy both conditions.

Such coverage for completed operations must be maintained for at least two (2) years following final acceptance of the work performed under the contract.

c. **Property Insurance (Builder's Risk/Installation Floater)**

The CM shall ensure that it and all Principal Trade and Specialty Contractors shall purchase and maintain property insurance during the life of this contract, upon the entire work at the

site to the full insurable value thereof. This insurance shall include the interests of the Owner, the CM, and subcontractors in the work and shall insure against the perils of fire, extended coverage, and vandalism and malicious mischief. If the Owner is damaged by failure of the CM to purchase or maintain such insurance, then the CM shall bear all reasonable costs properly attributable thereto; the CM shall affect and maintain similar property insurance on portions of the work stored off the site when request for payment per articles so includes such portions.

d. **Deductible**

Any deductible, if applicable to loss covered by insurance provided, is to be borne by the CM and/or the Principal Trade or Specialty Contractor as applicable.

e. **Other Insurance**

The CM shall ensure that it and all Principal Trade and Specialty Contractors shall obtain such additional insurance as may be required by the Owner or by the General Statutes of North Carolina including motor vehicle insurance, in amounts not less than the statutory limits.

f. **Proof of Carriage**

The CM shall ensure that it and all Principal Trade and Specialty Contractors shall furnish the Owner with satisfactory proof of carriage of the insurance required before written approval is granted by the Owner.

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ARTICLE 35 - PERFORMANCE BOND AND PAYMENT BOND

a. The CM shall furnish a performance bond and payment bond executed by a surety company authorized to do business in North Carolina. The bonds shall be in the full contract amount, which shall be in the amount of the GMP for the entire project. Bonds shall be executed in the form bound with the specifications

b. All bonds shall be countersigned by an authorized agent of the bonding company who is licensed to do business in North Carolina.

ARTICLE 36 - CONTRACTOR'S AFFIDAVIT

The final payment of retained amount due the CM on account of the contract shall not become due until the CM has furnished to the Owner through the designer an affidavit signed, sworn and notarized to the effect that all payments for materials, services or subcontracted work to Principal Trade and Specialty Contractors in connection with his contract have been satisfied, and that no claims or liens exist against the CM in connection with this contract. In the event that the CM cannot obtain similar affidavits from the Principal Trade and Specialty Contractors to protect the CM and the Owner from possible liens or claims against the subcontractor, the CM shall state in his affidavit that no claims or liens exist against any subcontractor to the best of his (the CM's) knowledge, and if any appear afterward, the CM shall save the Owner harmless.

ARTICLE 37 - ASSIGNMENTS

The CM shall not assign any portion of this contract nor subcontract in its entirety. Except as may be required under terms of the performance bond or payment bond, no funds or sums of money due or become due the CM under the contract may be assigned.

ARTICLE 38 - USE OF PREMISES

a. The CM shall confine his apparatus, the storage of materials and the operations of his workmen to limits indicated by law, ordinances, permits or directions of the designer and shall not exceed those established limits in his operations.

b. The CM shall not load or permit any part of the structure to be loaded with a weight that will endanger its safety.

c. The CM shall enforce the designer's and owner's instructions regarding signs, advertisements, fires and smoking.

d. No firearms, any type of alcoholic beverages or drugs (other than those prescribed by a physician) will be permitted at the job site.

ARTICLE 39 - CUTTING, PATCHING AND DIGGING

a. The CM shall ensure that all cutting, fitting or patching that may be required to make the work come together properly and fit it to receive or be received by work of other contractors shown upon or reasonably implied by the drawings and specifications for the completed structure, as the designer may direct.

b. Any cost brought about by defective or ill-timed work shall be borne by the party responsible therefor.

c. No Principal Trade or Specialty Contractor shall endanger any work of another such contractor by cutting, digging or other means, nor shall he cut or alter the work of any other such contractor without the consent of the designer and the affected contractor(s).

ARTICLE 40 - UTILITIES, STRUCTURES, SIGNS

a. The CM shall provide necessary and adequate facilities for water, electricity, gas, oil, sewer, and other utility services, which may be necessary and required for completion of the project. If the Owner specifies that the CM is to pay all utilities, any permanent meters installed shall be listed in the CM's name until his work is fully accepted by the Owner. As stipulated in the Supplementary General Conditions, the Owner may: (1) pay utilities cost directly, (2) require the CM to pay all utilities cost, (3) or reimburse the CM for the actual cost of utilities. The Owner or CM, as applicable, may recover actual costs of metered utilities from the responsible party should delays occur in project completion. Coordination of the work of the utility companies during construction is the sole responsibility of the CM.

b. If applicable Meters shall be relisted in the Owner's name on the day following completion and acceptance of the CM's work, and the Owner shall pay for services used after that date.

c. Prior to the operation of permanent systems, the CM will provide temporary power, lighting, water, and heat to maintain space temperature above freezing, as required for construction operations.

d. The CM shall ensure that the permanent building systems are in sufficient readiness for furnishing temporary climatic control at the time a building is enclosed and secured. The HVAC systems shall maintain climatic control throughout the enclosed portion of the building sufficient to allow completion of the interior finishes of the building. A building shall be considered enclosed and secured when windows**,** doorways (exterior, mechanical, and

electrical equipment rooms), and hardware are installed*;* and other openings have protection, which will provide reasonable climatic control. The appropriate time to start the mechanical systems and climatic condition shall be jointly determined by the CM and the designer. Use of the equipment in this manner shall in no way affect the warranty requirements of the CM.

e. The CM shall coordinate the work so that the building's permanent power wiring distribution system shall be in sufficient readiness to provide power as required by the HVAC contractor for temporary climatic control.

f. The CM shall coordinate the work so that the building's permanent lighting system shall be ready at the time interior painting and finishing begins and shall provide adequate lighting in those areas where interior painting and finishing is being performed.

g. The CM shall be responsible for his permanently fixed service facilities and systems in use during progress of the work. The following procedures shall be strictly adhered to:

    1. Prior to acceptance of work by the State Construction Office, the CM shall coordinate the removal and replacement of any parts of the permanent building systems damaged through use during construction.

    2. Temporary filters as recommended by the equipment manufacturer in order to keep the equipment and ductwork clean and free of dust and debris shall be installed in each of the heating and air conditioning units and at each return grille during construction. New filters shall be installed in each unit prior to the Owner's acceptance of the work.

    3. Extra effort shall be maintained to keep the building and the site adjacent to the building clean and under no circumstances shall air systems be operated if finishing and site work operations are creating dust in excess of what would be considered normal if the building were occupied.

    4. It shall be understood that any warranty on equipment presented to the Owner shall extend from the day of final acceptance by the Owner. The cost of warranting the equipment during operation in the finishing stages of construction shall be borne by the contractor whose system is utilized.

    5. The CM shall ensure that all lamps are in proper working condition at the time of final project acceptance.

h. The CM shall provide, if required and where directed, a shed for toilet facilities and shall furnish and install in this shed all water closets required for a complete and adequate sanitary arrangement. These facilities will be available to other contractors on the job and shall be kept in a neat and sanitary condition at all times. Chemical toilets are acceptable.

i. The CM shall, if required by the Supplementary General Conditions and where directed, erect a temporary field office, complete with lights, telephone, heat and air conditioning. A portion of this office shall be partitioned off, of sufficient size, for the use of a resident inspector, should the designer so direct.

j. On multi-story construction projects, the CM shall either provide or ensure that temporary elevators, lifts, or other necessary special equipment is available for the general use of all contractors. The cost for such elevators, lifts or other special equipment and the operation thereof shall either be included in the CM Construction Management Fee or specified as part of the work of a Principal Trade or Specialty Contractor and paid for as a part of the Cost of the Work.

k. The CM will erect one sign on the project if required. The sign shall be of sound construction, and shall be neatly lettered with black letters on white background. The sign shall bear the name of the project, and the CM's name, and the name of the designer and consultants. Directional signs may be erected on the Owner's property subject to approval of the Owner with respect to size, style and location of such directional signs. Such signs may bear the name of the contractor and a directional symbol. No other signs will be permitted except by permission of the Owner.

ARTICLE 41 - CLEANING UP

a. The CM shall ensure that the building and surrounding area is reasonably free from rubbish at all times, and shall remove debris from the site on a timely basis or when directed to do so by the designer. The CM shall provide an on-site refuse container(s) for the use of all Principal Trade and Specialty Contractors. The CM shall ensure that each Principal Trade and Specialty Contractor removes their rubbish and debris from the building on a daily basis. The CM shall ensure that the building is broom cleaned as required to minimize dust and dirt accumulation.

b. The CM shall provide and maintain suitable all-weather access to the building.

c. Before final inspection and acceptance of the building, the CM shall ensure that all portions of the work are clean, including glass, hardware, fixtures, masonry, tile and marble (using no acid), clean and wax all floors as specified, and completely prepare the building for use by the Owner, with no cleaning required by the Owner.

ARTICLE 42 - GUARANTEE

a. The CM shall unconditionally guarantee materials and workmanship against patent defects arising from faulty materials, faulty workmanship or negligence for a period of twelve (12) months following the date of final acceptance of the work or beneficial occupancy and shall replace such defective materials or workmanship without cost to the Owner.

b. Where items of equipment or material carry a manufacturer's warranty for any period in excess of twelve (12) months, then the manufacturer's warranty shall apply for that particular piece of equipment or material. The CM shall replace such defective equipment or materials, without cost to the Owner, within the manufacturer's warranty period.

c. Additionally, the Owner may bring an action for latent defects caused by the negligence of the CM, which is hidden or not readily apparent to the Owner at the time of beneficial occupancy or final acceptance, whichever occurred first, in accordance with applicable law.

d. Guarantees for roof, equipment, materials, and supplies shall be stipulated in the specification sections governing such roof, equipment, materials, or supplies.

ARTICLE 43 - CODES AND STANDARDS

Wherever reference is given to codes, standard specifications or other data published by regulating agencies including, but not limited to, national electrical codes, North Carolina State Building Codes, federal specifications, ASTM specifications, various institute specifications, etc., it shall be understood that such reference is to the latest edition including addenda published prior to the date of the contract documents.

ARTICLE 44 - INDEMNIFICATION

To the fullest extent permitted by law, the CM shall indemnify and hold harmless the Owner, the designer and the agents, consultants and employees of the Owner and designer, from and against all claims, damages, losses and expenses, including, but not limited to, attorneys' fees, arising out of or resulting from the performance or failure of performance of the work, provided that any such claim, damage, loss or expense (1) is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the work itself) including the loss of use resulting therefrom, and (2) is caused in whole or in part by any negligent act or omission of the CM, the CM's subcontractor, or the agents of either the CM or the CM's subcontractor. Such obligation shall not be construed to negate, abridge or otherwise reduce any other right or obligation of indemnity which would otherwise exist as to any party or person described in this article.

ARTICLE 45 - TAXES

a. Federal excise taxes do not apply to materials entering into state work (Internal Revenue Code, Section 3442(3)).

b. Federal transportation taxes do not apply to materials entering into state work (Internal Revenue Code, Section 3475(b) as amended).

c. North Carolina sales tax and use tax, as required by law, do apply to materials entering into state work and such costs shall be included in the bid proposal and contract sum.

d. Local option sales and use taxes, as required by law, do apply to materials entering into state work as applicable and such costs shall be included in the bid proposal from Principal Trade and specialty Contractors and contract sum.

e. Accounting Procedures for Refund of County Sales & Use Tax

   Amount of county sales and use tax paid per CM's statements:

   CM's performing contracts for state agencies shall ensure that the Principal Trade and Specialty Contractors provide information to allow the CM to give the state agency for whose project the materials, supplies, fixtures and/or equipment was purchased a signed statement containing the information listed in N.C.G.S. 105-164.14(e).

   The Department of Revenue has agreed that in lieu of obtaining copies of sales receipts from contractors, an agency may obtain a certified statement from the contractors setting forth the date, the type of property and the cost of the property purchased from each vendor, the county in which the vendor made the sale and the amount of local sales and use taxes paid thereon. If the property was purchased out-of-state, the county in which the property was delivered should be listed. The contractor should also be notified that the certified statement may be subject to audit.

   In the event the contractors make several purchases from the same vendor, such certified statement must indicate the invoice numbers, the inclusive dates of the invoices, the total amount of the invoices, the counties, and the county sales and use taxes paid thereon.

   Name of taxing county: The position of a sale is the retailer's place of business located within a taxing county where the vendor becomes contractually obligated to make the sale. Therefore, it is important that the county tax be reported for the county of sale rather than the county of use.

When property is purchased from out-of-state vendors and the county tax is charged, the county should be identified where delivery is made when reporting the county tax.

Such statement must also include the cost of any tangible personal property withdrawn from the contractor's warehouse stock and the amount of county sales or use tax paid thereon by the CM.

Contractors are not to include any tax paid on supplies, tools and equipment which they use to perform their contracts and should include only those building materials, supplies, fixtures and equipment which actually become a part of or annexed to the building or structure.

ARTICLE 46 - EQUAL OPPORTUNITY CLAUSE

The non-discrimination clause contained in Section 202 (Federal) Executive Order 11246, as amended by Executive Order 11375, relative to equal employment opportunity for all persons without regard to race, color, religion, sex or national origin, and the implementing rules and regulations prescribed by the Secretary of Labor, are incorporated herein.

ARTICLE 47 - EMPLOYMENT OF INDIVIDUALS WITH DISABILITIES

The CM agrees not to discriminate against any employee or applicant for employment because of physical or mental handicap in regard to any position for which the employee or applicant is qualified. The CM agrees to take affirmative action to employ, advance in employment and otherwise treat qualified handicapped individuals without discrimination based upon their physical or mental handicap in all employment practices.

ARTICLE 48 - ASBESTOS-CONTAINING MATERIALS (ACM)

The State of North Carolina has attempted to address all asbestos-containing materials that are to be disturbed in the project. However, there may be other asbestos-containing materials in the work areas that are not to be disturbed and do not create an exposure hazard. Construction Managers are reminded of the requirements of instructions under General Conditions of the Contract, titled Examination of Conditions. Statute 130A, Article 19, amended August 3, 1989, established the Asbestos Hazard Management Program that controls asbestos abatement in North Carolina. The latest edition of *Guideline Criteria for Asbestos Abatement* from the State Construction Office is to be incorporated in all asbestos abatement projects for the Capital Improvement Program.

ARTICLE 49 - MINORITY BUSINESS PARTICIPATION

N.C.G.S. 143-128.2 establishes a ten percent (10%) goal for participation by minority businesses in total value of work for each State building project and requires documentation of good faith efforts for meeting that goal. The document, *Guidelines for Recruitment and Selection of Minority Businesses for Participation in State Construction Contracts* including Affidavits and Appendix F are hereby incorporated into and made a part of this contract.

The CM shall identify and define contract packages (the value of which shall total to at least ten percent (10%) of the GMP) that remove barriers to participation commonly experienced by Historically Underutilized Businesses and Minority Business Enterprises as those terms are defined in North Carolina General Statute 143-128.2, hereinafter referred to as Reduced Barrier Packages (RBP). Such contract packages will be submitted to the Owner for review. As an example, RBP's may require no performance or payment bond, or may offer the participation of the CM as a guarantor or surety in the financing of material purchases by the Principal Trade and/or Specialty Contractors, provided that the CM may condition such financing participation upon the

issuance of joint checks or other similar arrangements to allow the CM to verify that timely payments are made to suppliers furnishing credit. The CM may propose other and/or additional provisions for reducing barriers to participation.

The Owner shall require the CM to submit a plan for compliance with N.C.G.S.143-128.2 by approval by the Owner prior to soliciting bids for the Principal Trade and Specialty Contracts. The CM and Principal Trade and Specialty Contractors shall make a good faith effort to recruit and select minority businesses for participation in contracts pursuant to N.C.G.S. 143-128.2.

ARTICLE 50 – CONTRACTOR EVALUATION

The CM's overall work performance on the project shall be fairly evaluated in accordance with the State Building Commission policy and procedures, for determining qualifications to compete for future capital improvement projects for institutions and agencies of the State of North Carolina. In addition to final evaluation, interim evaluation may be prepared during the progress of project. The document, Construction Manager Evaluation Procedures, is hereby incorporated and made a part of this contract. The Owner may request the CM's comments to evaluate the designer.

ARTICLE 51 – GIFTS

Pursuant to N.C. Gen. Stat. § 133-32, it is unlawful for any vendor or contractor (i.e. architect, bidder, contractor, construction manager, design professional, engineer, subcontractor, supplier, vendor, etc.), to make gifts or to give favors to any State employee. This prohibition covers those vendors and contractors who: (1) have a contract with a governmental agency; or (2) have performed under such a contract within the past year; or (3) anticipate bidding on such a contract in the future. For additional information regarding the specific requirements and exemptions, vendors and contractors are encouraged to review G.S. Sec. 133-32.

During the construction of the Project, the Contractor is prohibited from making gifts to any of the Owner's employees, Owner's project representatives (architect, engineers, construction manager and their employees), employees of the State Construction Office and/or any other State employee that may have any involvement, influence, responsibilities, oversight, management and/or duties that pertain to and/or relate to the contract administration, financial administration and/or disposition of claims arising from and/or relating to the Contract and/or Project.

ARTICLE 52 – AUDITING-ACCESS TO PERSONS AND RECORDS

In accordance with N.C. General Statute 147-64.7, the State Auditor shall have access to Contractor's officers, employees, agents and/or other persons in control of and/or responsible for the Contractor's records that relate to this Contracts for purposes of conducting audits under the referenced statute. The Owner's internal auditors shall also have the right to access and copy the Contractor's records relating to the Contract and Project during the term of the Contract and within two years following the completion of the Project/close-out of the Contract to verify accounts, accuracy, information, calculations and/or data affecting and/or relating to Contractor's requests for payment, requests for change orders, change orders, claims for extra work, requests for time extensions and related claims for delay/extended general conditions costs, claims for lost productivity, claims for loss efficiency, claims for idle equipment or labor, claims for price/cost

escalation, pass-through claims of subcontractors and/or suppliers, and/or any other type of claim for payment or damages from Owner and/or its project representatives.

ARTICLE 53 – NORTH CAROLINA FALSE CLAIMS ACT

The North Carolina False Claims Act ("NCFCA"), N.C Gen. Stat. § 1-605 through 1-618, applies to this Contract. The Contractor should familiarize itself with the entire NCFCA and should seek the assistance of an attorney if it has any questions regarding the NCFCA and its applicability to any requests, demands and/or claims for payment its submits to the State through the contracting state agency, institution, university or community college.

The purpose of the NCFCA "is to deter persons from knowingly causing or assisting in causing the State to pay claims that are false or fraudulent and to provide remedies in the form of treble damages and civil penalties when money is obtained from the State by reason of a false or fraudulent claim." (Section 1-605(b).) A contractor's liability under the NCFCA may arise from, but is not limited to: requests for payment, invoices, billing, claims for extra work, requests for change orders, requests for time extensions, claims for delay damages/extended general conditions costs, claims for loss productivity, claims for loss efficiency, claims for idle equipment or labor, claims for price/cost escalation, pass-through claims of subcontractors and/or suppliers, documentation used to support any of the foregoing requests or claims, and/or any other request for payment from the State through the contracting state agency, institution, university or community college. The parts of the NCFCA that are most likely to be enforced with respect to this type of contract are as follows:

- A "claim" is "[a]ny request or demand, whether under a contract or otherwise, for money or property and whether or not the State has title to the money or property that (i) is presented to an officer, employee, or agent of the State or (ii) is made to a contractor … if the money or property is to be spent or used on the State's behalf or to advance a State program or interest and if the State government: (a) provides or has provided any portion of the money or property that is requested or demanded; or (b) will reimburse such contractor … for any portion of the money or property which is requested or demanded." (Section 1-606(2).)

- "Knowing" and "knowingly." – Whenever a person, with respect to information, does any of the following: (a) Has actual knowledge of the information; (b) Acts in deliberate ignorance of the truth or falsity of the information; and/or (c) Acts in reckless disregard of the truth or falsity of the information. (Section 1-606(4).) Proof of specific intent to defraud is not required. (Section 1-606(4).)

- "Material" means having a natural tendency to influence, or be capable of influencing, the payment or receipt of money or property. (Section 1-606(4).)

- Liability. – "Any person who commits any of the following acts shall be liable to the State for three times the amount of damages that the State sustains because of the act of that person[:] … (1) Knowingly presents or causes to be presented a false or fraudulent claim for payment or

approval. (2) Knowingly makes, uses, or causes to be made or used, a false record or statement material to a false or fraudulent claim. (3) Conspires to commit a violation of subdivision (1), (2) …" (Section 1-607(a)(1), (2).)

- The NCFCA shall be interpreted and construed so as to be consistent with the federal False Claims Act, 31 U.S.C. § 3729, et seq., and any subsequent amendments to that act. (Section 1-616(c).)

Finally, the contracting state agency, institution, university or community college may refer any suspected violation of the NCFCA by the Contractor to the Attorney General's Office for investigation. Under Section 1-608(a), the Attorney General is responsible for investigating any violation of NCFCA, and may bring a civil action against the Contractor under the NCFCA. The Attorney General's investigation and any civil action relating thereto are independent and not subject to any dispute resolution provision set forth in this Contract. (See Section 1-608(a).)

ARTICLE 54 – TERMINATION FOR CONVENIENCE

a. Owner may at any time and for any reason terminate CM's services and work at Owner's convenience. Upon receipt of such notice, CM shall, unless the notice directs otherwise, immediately discontinue the work and placing of orders for materials, facilities and supplies in connection with the performance of this Agreement.

b. Upon such termination, CM shall be entitled to payment only as follows: (1) the actual cost of the work completed in conformity with this Agreement; plus, (2) such other costs actually incurred by CM as are permitted by the prime contract and approved by Owner; (3) plus ten percent (10%) of the cost of the work referred to in subparagraph (1) above for overhead and profit. There shall be deducted from such sums as provided in this subparagraph the amount of any payments made to CM prior to the date of the termination of this Agreement. CM shall not be entitled to any claim or claim of lien against Owner for any additional compensation or damages in the event of such termination and payment.

000006 – SUPPLEMENTARY GENERAL CONDITIONS

PART 1 - GENERAL

1.1 SUMMARY

The following modifies the January 2013 rev 1 edition of the General Conditions of the Contract, State of North Carolina Form OC-15 CMR, and supersedes them only as modified per this document. CM and CMR will hereinafter refer to the Construction Manager at Risk.

A. ARTICLE I - Definitions:

1. Paragraph “b” Add the following to the end of the paragraph:

   Owner's representative: North Carolina Department of Cultural and Natural Resources (NCDCNR) represents the Owner in all matters pertaining to construction contracts. NCDCNR will designate a Project Manager, James Mancari, for the project. All official contacts, decisions, directions, problem resolution, and coordination required with NCDCNR and Ft. Fisher Aquarium will be through the Project Manager. This requirement does not modify the responsibilities of the Designer as stated in the General Conditions. The term Owner, NCDCNR Project Manager and Ft. Fisher Aquarium Representative shall be synonymous.

2. Paragraph “c” Add the following second sentence:

   The Designer or Project Designer as referred to herein shall mean Architect or Engineer and throughout the documents the word designer or project designer shall mean Designer.

3. Paragraph “d” Add the following second sentence:

   The CM, CMa or CMR as referred to herein shall mean the Construction Manager at Risk.

4. Paragraph “l” Add the following sentence:

   Refer to Section 013200 “Construction Progress Documentation” for the definition of “Schedule” as it relates to “Time of Completion”.

5. Paragraph “t” Delete this paragraph and replace with the following:

   “Or approved equal”, “equivalent”, and “equal to” shall mean a product or products by manufacturers other than those listed in the specifications that may be incorporated into the work, subject to compliance with the requirements of the section, and after review and concurrence by the Designer and the Owner.

6. Paragraph “u” “Substitute” or “substitution" shall mean a product or products by manufacturers not listed in the specifications and are not an “or approved equal”, “equivalent” or an “equal to.”

7. Paragraph “v” Delete this paragraph and replace with the following:

   “Provide" shall mean furnish and install complete, in place, new, clean, fully tested, operational, and ready for use.

8. Paragraph “cc” Add the following after “Final Acceptance”:

   Or “Acceptance by Owner”.

9. Paragraph “dd” Add the following new paragraph:

   “Latest edition" shall mean the current printed version of the referenced document issued up to 30 calendar days prior to date of receipt of bids, unless specified otherwise

10. Paragraph “ee” Add the following new paragraph:

    “Drawings" or "plans" shall mean the drawings enumerated in the contract documents, as well as all the information in the detail manual when applicable, addenda, and designer prepared field drawings, bulletin and clarification drawings.

11. Paragraph “ff” Add the following new paragraph:

    "Specifications" mean this project manual and addenda thereto.

B. ARTICLE 4 is appended as follows:

1. Cost for additional complete sets of Plans and Specifications will be $1,600.00.

2. Construction Documents are available to Bidders on the Designers “Cloud” site and access to that site will be provided free of charge when requested by a Bidder.

C. ARTICLE 5; Replace paragraphs b. and c with the contents of Section 013300, Submittal Procedures.

D. ARTICLE 6; Refer to Section 017839 for supplemental information regarding Record Drawings and Specifications.

E. ARTICLE 14; Add the following new Paragraph “i”: “Refer to Section 013200 for additional specific requirements regarding Construction Progress Documentation”.

F. ARTICLE 14; Add the following new Paragraph “j”: “Refer to Section 013100 for additional specific requirements regarding Construction Progress Meetings”.

G. ARTICLE 14; Add the following new Paragraph “k”: “Refer to Section 017300 for additional specific requirements regarding Project Layout Documentation”.

H. ARTICLE 15 is hereby deleted for this Project.

H. ARTICLE 19; Add the following new Paragraph “k”: “Refer to Section 012600 for additional specific instructions regarding Changes in the Work”.

I. ARTICLE 23;

1. Add to Paragraph “a”: Time for Completion:

1. The Work of this portion of the Project will be completed within XXX calendar days.

2. Unless stated otherwise, Notice to Proceed will be determined in the Pre-Construction Conference.

3. The CMR’s Schedule is to be used for the tracking of the progress of the work and has no other demonstrable purpose.

4. If the Work is not completed by the Time for Acceptance by the Owner then the Owner will assess the General Contractor an amount of $XXX per day.

J. ARTICLE 31; Refer to Section 012900 (except for 1.3, G, H, and I) for specific instructions regarding Requests for Payment.

K. ARTICLE 32; Refer to Section 012900, 3.1, G, H, and I for more specific information regarding Final Payment Requirements.

L. ARTICLE 38; add the following:

e. General: CMR shall have limited use of Project site for construction operations as indicated on Drawings by the Contract limits and as indicated by requirements of this Section.

f. Limit use of Project site to work in areas designated for each phase and areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

g. The Owner will designate space for laydown, dumpster, and worker parking.

h. Keep driveways, loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.

1. Schedule deliveries to minimize use of driveways and entrances by construction operations.
2. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

M. ARTICLE 41; append to the end of this article the information in Section 017300, paragraph 3.6, for additional cleaning requirements as paragraph “d”.

1.2 WORK UNDER SEPARATE CONTRACTS

A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract or other contracts. Coordinate the Work of this Contract with work performed under separate contracts.

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Report of Geotechnical Exploration
NC Aquarium Ft. Fisher Addition
Kure Beach, North Carolina
S&ME Project No. 23060119

PREPARED FOR:

North Carolina Aquariums
3125 Poplarwood Court, Suite 160
Raleigh, North Carolina 27604

PREPARED BY:

S&ME, Inc.
3006 Hall Waters Drive, Suite 100
Wilmington, North Carolina 28405

May 16, 2024

May 16, 2024

North Carolina Aquariums
3125 Poplarwood Court, Suite 160
Raleigh, North Carolina 27604

Attention: Mr. James Mancari
Division Project Manager

Reference: **Report of Geotechnical Exploration**
NC Aquarium Ft. Fisher Addition
Kure Beach, North Carolina
S&ME Project No. 23060119
NC PE Firm License No. F-0176

Dear Mr. Mancari:

S&ME, Inc. (S&ME) has completed the geotechnical exploration for the referenced project located in Kure Beach, North Carolina. Our services were performed in general accordance with S&ME Proposal No. 23060119, dated September 27, 2023, and the Agreement, dated December 21, 2023, fully executed on January 10, 2024.

The purpose of this exploration was to obtain subsurface information to allow characterization of the subsurface conditions at the site and to develop recommendations concerning earthwork and foundations, as they relate to design and construction of the proposed structures at the site.

This report describes our understanding of the project, presents the results of the field exploration, laboratory testing, and engineering analysis, and discusses our geotechnical conclusions and recommendations based on these considerations.

S&ME appreciates this opportunity to be of service to you. Please contact us if you have questions concerning this report or any of our services.

Sincerely,

S&ME, Inc.

Nathan Buffum, P.E.
Office Principal / Vice President
NC Registration No. 042575



Thomas Still, P
Principal Engi
NC Registrati

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Report at a Glance

Key geotechnical findings based on our current understanding of the proposed project are presented below. These findings are presented as an overview and should not be used in place of the more detailed recommendations presented in the remainder of this report.

Category	Key Geotechnical Finding
Subsurface Conditions	• Previously placed fill and very loose to loose near-surface sands to depths of 3 feet. • Beneath near-surface soils, medium dense to very dense sands to exploration termination depths. • Soft to stiff clay layers, varying in thickness from about 1 to 10 feet, encountered within the sands at depths ranging from about 24 to 34 feet. • At depths below about 40 feet, recovered samples from borings included cemented fragments. • Varying subsurface water levels approximately 0.1 to 5 feet below the ground surface.
Site Development	• Drainage should be established early, so water levels are maintained at least 2 feet or more below working surfaces. • Densification of existing loose near-surface soils after stripping, prior to fill placement. • Soils encountered in the upper subsurface profile area generally suitable for re-use as fill but will likely require moisture conditioning to obtain specified compaction and stability.
Excavation Conditions	• Difficult to excavate materials not anticipated. • The contractor should be prepared to dewater where utility or foundation excavations extend beneath subsurface water levels and control any water that collects in excavations. • Excavations below groundwater may encounter loose, unstable excavation bottoms that require stabilization.
Seismic Considerations	• Seismic Design Category C for Risk Category classification of I, II, or III (ASCE 7-10). • Seismic Site Class D. • Liquefaction risk is low, and liquefaction-induced damage is not expected.
Foundation Type	• Auger Cast-in-place (ACIP) piles. Evaluations included 14-inch and 16-inch diameters. • Shallow Spread Foundations (single-story generator and electrical building, single-story elevated mechanical) • Preliminary evaluation of 8-inch diameter micropiles for potential support of the Touch Tank.
Slab Support	• On-grade for thin (non-structural) grade slabs.

1.0 Project Information

The purpose of this exploration was to obtain subsurface information to allow characterization of the subsurface conditions at the site and to develop recommendations concerning earthwork and foundations, as they relate to design and construction of the proposed structure at the site. This report describes our understanding of the project, presents the results of the field exploration, laboratory testing, and engineering analysis, and discusses our geotechnical conclusions and recommendations based on these considerations.

1.1 Site and Project Description

Project information was provided during email correspondence in August and September of 2023, between Mr. Mancari and team members from Szostak Design, Bennett & Pless, and S&ME. In an email on August 21, 2023, Mr. Mancari provided the following documents:

1. Memorandum outlining geotechnical requirements for the project, prepared by Klaus Perkins (Bennett & Pless), dated August 21, 2023.
2. A site plan depicting existing site features and the proposed new building footprint, undated.
3. Existing building layout drawings, each for levels 1 through 3, related to the hazardous materials survey proposal request.

An online meeting occurred on September 6, 2023, to further discuss aspects of the project and proposed services to be provided by S&ME. On September 7, 2023, Mr. Phil Nelson (Szostak Design) provided a link to access 90% Schematic Design drawings and original drawings for the previous buildings constructed in 1973 and 1999. On January 11, 2024, Mr. Dan Armento (Clancy & Theys) provided a link to access 100% Schematic Design drawings.

Additional project discussions occurred during a site meeting on January 19, 2024, and subsequent online calls in February, March, and April, 2024.

1.1.1 Site Description

The project site is located at the existing Ft. Fisher Aquarium, on Loggerhead Road, in Kure Beach, North Carolina. The site area for the proposed building additions is located on the northeast, east, and southeast sides of the existing building. Existing conditions in these areas include wooded and low-lying areas, grassed and gravel-covered surfaces, utilities and fencing, and asphalt and concrete pavements.

1.1.2 Project Description

The project will include building additions totaling approximately 20,000 square feet in plan area. The Shark Tank building addition will be up to five stories in height. Structural components will include reinforced concrete slabs, columns, beams, and walls, and potentially structural steel framing.

Based on conversations with the design team, the foundation support for the Shark Tank building addition will be provided by augered cast-in-place (ACIP) piles incorporated into pile caps and grade beams, similar to portions of the existing building. We understand that soil-supported grade slabs may be utilized in some areas of the new building while some areas will require the use of pile-supported reinforced structural slabs or mat foundations.

Based on the provided information, typical building interior and exterior column loads will be 700 kips and 400 kips, respectively, or less. A Shark Tank will be constructed in the new addition and impose an additional floor slab area load of 1,152 psf to 1,344 psf due to water weight. Tank foundations may consist of reinforced structural slabs, 12 inches or more in thickness. Slabs-on-grade to be constructed in the building addition are planned to be 4 inches in thickness and we have assumed floor slab loads in these areas will be 150 psf or less (including slab self-weight).

A new Touch Tank will be constructed in the northeast corner of the existing building and impose an additional floor slab area load of about 192 psf due to water weight. Due to height restrictions within the existing building, foundation support for the Touch Tank may include micropiles.

A new single-story generator and electrical building will be constructed on the south side of the existing building, having approximately 1,300 square feet in plan area. An elevated single-story mechanical building will be constructed southeast of the existing building, having approximately 3,000 square feet in plan area. Although structural loads for these structures were not provided, we understand that shallow foundations are planned, and assume column and wall loads will be 50 kips and 3 kips per foot, respectively, or less.

Based on the information available, it appears that existing grades within the proposed Shark Tank building addition range from about 3 feet to 9 feet above MSL. Finished floor elevations within the building will vary from about 2 to 11 feet, such that minor cuts and up to about 6 feet of fill placement may be required during site grading. Within the generator and electrical building, up to 4 feet of fill placement may be required.

2.0 Methods of Exploration

2.1 Field Exploration

Before visiting the site, NC 811 was contacted for clearance to drill at the site. We also subcontracted a private utility locate service to help identify potential buried utilities near proposed test locations. We then proceeded to perform the following tasks using the information provided:

1. We performed a site walkover, observing general features of topography, existing structures, ground cover, and surface soils at the project site.
2. We established the locations of four standard penetration test (SPT) boring locations across the proposed building location, labeled B-1 through B-4, and four cone penetration test (CPT) soundings, labeled S-1 through S-4. Relative to the initially proposed scope, one of the planned SPT borings was replaced with one CPT sounding after the CPT rig was successful in advancing to target depths.
3. We advanced the SPT borings to depths ranging from 45 feet to 60 feet. Each SPT boring was advanced by mud rotary slurry drilling methods.
4. In conjunction with the standard penetration testing, split-spoon disturbed soil samples were recovered at regular depth intervals within the borings and transported to our laboratory for further evaluation.
5. CPT soundings were advanced to target depths of 60 to 67 beneath the existing ground surface.
6. In conjunction with soundings S-1 and S-3, downhole shear wave velocity measurements were obtained at approximate 1-meter depth intervals.

7. At each CPT test location, we advanced one hand auger boring without penetration testing to a target depth of 4 feet, to observe topsoil thicknesses and near-surface soil types. Near sounding S-4, two hand auger borings were performed (S-4A and S-4B).
8. Subsurface water levels at each sounding and boring were measured in the field at the end of the drilling day. Water levels within SPT borings were also measured at least 24 hours after drilling. The borings were backfilled with soil cuttings following water level measurements.

The approximate test locations are shown on the Test Location Sketch included as Figure 1 in Appendix I. A brief description of the field exploration procedures performed, soil classification legends, the sounding logs, and the boring logs are attached in Appendix II.

2.2 Laboratory Testing

Representative soil samples encountered within the soil test borings were collected and transported to our laboratory. The recovered soil samples were classified in general accordance with the visual-manual method described in ASTM D 2488, "Standard Practice for Description and Identification of Soils (Visual-Manual Method)". At the discretion of the geotechnical engineer, no further laboratory testing was performed for this exploration.

3.0 Site And Surface Conditions

3.1 Site Conditions

Based on the topographic map provided and site observations, the ground surfaces within the building addition area generally slope down from an elevation of about 8 feet MSL near the existing building to about 3 feet in the low-lying areas to the northeast, east, and south. Ground surface elevations at the test locations were not surveyed.

In general, no surficial topsoil layer of appreciable thickness was encountered at our test locations, although several test locations were located in areas of wetland vegetation and others in areas of sparse grasses.

3.2 Local Geology

The site is located in the Coastal Plain Physiographic Region of North Carolina. The Coastal Plain Province is typically characterized by marine, alluvial, and aeolian sediments that were deposited during periods of fluctuating sea levels and moving shorelines. The soils and basal formations in the North Carolina Coastal Plain Physiographic Province are typical of those laid down in a shallow sloping sea bottom; interbedded sands and clays with irregular deposits of shells and layers of limestone and cemented sands. Alluvial sands, silts, and clays are typically present near rivers and creeks. Deposits of peat, organic silt, and organic clay are also typically present in or near current or former tidal marsh areas in the outer portion of the Coastal Plain.

According to the 1985 Geologic Map of North Carolina, the site is underlain by undivided surficial deposits of Quaternary age. These deposits consist of sand, clay, gravel, and peat deposited in marine, fluvial, eolian, and lacustrine environments.

4.0 Subsurface Conditions

The generalized subsurface conditions at the site are described below. For more detailed descriptions and stratifications at test locations, the respective sounding and boring logs should be reviewed in Appendix II. These logs represent our interpretation of the subsurface conditions based upon the field data. Stratification lines on the logs represent approximate boundaries between soil types and soil behavior types; however, the actual transition may be gradual.

4.1 Interpreted Subsurface Profile

An interpreted subsurface cross-sectional profile of the site soils is attached in Appendix I as Figure 2. The cross-section orientation in plan view is shown on Figure 1 in Appendix I. Profile A-A' is oriented generally south to north across the site and depicts soil conditions penetrated by our soundings and borings looking in a westerly direction.

The profile is provided to illustrate a general representation of the subsurface conditions within the proposed construction area. Note that the profile is not to scale. The subsurface profiles were prepared for illustrative purposes only. Subsurface stratifications may be more gradual than indicated, and conditions may vary between test locations.

4.2 Description of Subsurface Soils

4.2.1 Fill Material

Previously placed fill material was encountered within hand auger borings S-1 through S-4A to depths ranging from approximately 0.5 to 3 feet and consisted of poorly graded sands (USCS Classification "SP"). Varying amounts of gravel were observed mixed within the fill material.

Within the corresponding CPT soundings, near-surface soils within the upper 1 to 2 feet exhibited tip resistances of about 20 to 40 tons per square foot (tsf), indicating a loose relative density.

4.2.2 Coastal Plain Soils

Beneath the fill, and extending from the ground surface at other locations, Coastal Plain soils were encountered to termination depths of hand auger borings, SPT borings, and soundings. Samples recovered from the borings consisted of poorly graded sands (SP) and poorly graded sands with silt (SP-SM). Some shell materials were encountered in several borings between depths of about 5 to 10 feet. At depths below about 40 feet, recovered samples included some cemented fragments.

Soils within the upper 3 feet of SPT borings exhibited N-values ranging from 3 to 8 blows per foot (bpf), indicative of very loose to loose relative density. Beneath the loose upper sands, N-values typically ranged from about 9 to 35 bpf and indicated generally medium dense to dense relative density with some loose and very dense layers.

A layer of sandy clay (CL) was encountered within boring B-3, from depths of about 24 to 29 feet, and within boring B-4, from depths of about 24 to 34 feet. N-values within these clays varied from 4 to 6 bpf, indicating a soft to firm consistency.

CPT soundings encountered predominantly sandy Soil Behavior Types (SBT) exhibiting tip resistances typically ranging from about 120 to 360 tsf, indicating dense to very dense relative density. A relatively thin clay layer, ranging from less than one foot to about three feet in thickness, was encountered at depths ranging from about 25 to 28 feet. Tip resistances of 5 to 20 tsf indicate soft to stiff consistency within the cohesive layers.

Within soundings S-2 through S-4, below depths of about 43 to 48 feet, interbedded layers of sands, sand mixtures, and thin clay lenses were encountered to sounding termination depths of about 60 feet. The interbedded layers exhibited tip resistances widely varying from about 30 to 300 tsf, indicating interbedded lenses of loose to very dense relative density.

4.2.3 Groundwater

Water levels were measured upon completion of the CPT soundings and hand auger borings. Subsurface water at the time of the exploration was encountered at depths ranging from about 2 to 5 feet below existing ground surface in our CPT soundings. Water was not encountered within hand auger borings S-2 and S-3. Water was encountered in hand auger borings S-1, S-4A, and S-4B at respective depths of 1.5, 2.6, and 2.3 feet.

Water was measured within SPT borings after a waiting period of over 24 hours after drilling and ranged from 0.1 to 5.6 feet.

Subsurface water levels can be expected to fluctuate due to seasonal variations in rainfall, evaporation, tidal effects, and other factors. Additionally, perched water conditions may exist during the typically wetter winter months above less permeable dense sands encountered within the upper soil profile. Thus, shallower water levels may be encountered during wet weather grading.

5.0 Conclusions and Recommendations

The following conclusions and recommendations are based on our field exploration, our understanding of the proposed construction, our engineering analyses, experience with similar projects and subsurface conditions, and our correspondence with you. If structural loads and/or proposed site grades are different from those indicated, we should be provided the opportunity to review and comment upon the recommendations of this report so that they may be confirmed, extended, or modified as necessary. If subsurface conditions adverse to those indicated by this report are encountered during construction, those differences should be reported to us for review and comment.

Based on our review of the provided project information and geotechnical analyses of field testing data, this site appears generally adaptable for the proposed development. The following sections present our geotechnical conclusions and recommendations regarding design and construction.

5.1 Seismic Considerations

5.1.1 Seismic Site Class

Seismic site classification is based on the top 100 feet of a site's subsurface profile. Shear wave velocity profiles were developed from measurements recorded in seismic CPT soundings S-1 and S-3 to respective depths of about 67 and 60 feet. Using the collected data and S&ME's knowledge of the local geology, when extrapolated to a depth of 100 feet, average shear wave velocities of 904 and 1,157 ft/sec were estimated, which is greater than the 600 ft/sec that is required for consideration of Site Class D design parameters. Figures 3A and 3B in Appendix I present the Shear Wave Velocity Profiles developed from measurements recorded in soundings S-1 and S-3. Based on Section 1613.3.2 of the 2018 North Carolina Building Code (NCBC), the site is designated as **Seismic Site Class D**.

5.1.2 Liquefaction Triggering Evaluation and Liquefaction Potential

A liquefaction triggering evaluation was performed using the methods presented by Youd et. al. (2001), Boulanger and Idriss (2014), and recent research concerning the liquefaction resistance of aged sands (Hayati and Andrus, 2009). Following the method developed by Andrus, the shear wave velocity profiles have been used to determine measured-to estimated-velocity-ratio (MEVR) which in turn is related to age correction factors (K_{DR}) utilized in the liquefaction triggering evaluation.

Based on provisions of the NCBC, the design earthquake has a hazard equal to a 2 percent probability of exceedance in a 50-year period (2,475-year return period). Our liquefaction evaluation was based on an earthquake with a magnitude of 7.3. For Seismic Site Class D at the project site, the site modified peak ground acceleration is 0.184g (ASCE 7-10). The seismic hazard information was obtained from the United States Geologic Survey (USGS).

Based on the results of our analyses, we conclude that liquefaction is unlikely to occur under the design earthquake, and no further consideration of liquefaction is necessary for the design of the project.

5.1.3 Seismic Spectral Design Values for Site Class D

The current NCBC references the 2015 International Building Code and ASCE 7-10 for determining the design spectral accelerations and liquefaction potential; however, Seismic Ground Motion Maps were updated in 2014 and are incorporated into ASCE 7-16, which is referenced by the 2018 version of the International Building Code (IBC). The updated seismic maps, which result in lower spectral accelerations, represent updated understanding of the seismic hazards, and will presumably eventually be incorporated into the next edition of the NCBC, which is based on the IBC. Listed in the table below are the ground motion parameters from both resources, ASCE 7-10 and ASCE 7-16. Use of the newer, more up to date seismic parameters may require the authorization of the local Building Official.

Table 5-1: Ground Motion Parameters

Method	Site Class	S_S	S_1	S_{DS}	S_{D1}	PGA_M
2018 North Carolina Building Code (ASCE 7-10)	D	0.229g	0.094g	0.245g	0.151g	0.184g
2018 International Building Code (ASCE 7-16)	D	0.164g	0.071g	0.175g	0.114g	0.133g

5.1.4 *Seismic Design Category*

For a structure having a Risk Category classification of I, II, or III, the S_{DS} and S_{D1} values obtained are consistent with "Seismic Design Category C" as defined by the 2018 North Carolina Building Code and ASCE 7-10. For Risk Category IV, the values are consistent with "Seismic Design Category D".

For a structure having a Risk Category classification of I, II, or III, the S_{DS} and S_{D1} values obtained are consistent with "Seismic Design Category B" as defined by the 2018 International Building Code and ASCE 7-16. For Risk Category IV, the values are consistent with "Seismic Design Category C".

5.2 Augered Cast-in-Place (ACIP) Reinforced Concrete Piles

ACIP piles have the advantage of being relatively economical to install and have a comparatively high axial capacity regarding the soil conditions observed at this site versus other types of piles. ACIP piles appear to be a feasible deep foundation option to install at this site.

ACIP piles, or continuous flight auger (CFA) piles, are installed by drilling down to the desired penetration depth in a continuous operation. Once the desired penetration depth is reached, the pile is grouted as the auger is slowly extracted. This pile installation method does not densify the ground as it drills, because the drilled soils are removed from the ground as spoils. This method generates spoils that should be planned for handling during construction.

We do not recommend drilled displacement piles for this site based on the interpreted subsurface profile.

5.2.1 *Axial Pile Resistance*

Axial resistances versus depth were estimated for individual 16-inch and 18-inch diameter ACIP piles based upon the subsurface conditions encountered in the soundings and borings. Figure 4A of Appendix I presents a plot of the estimated single-pile allowable axial resistances for each foundation type.

The elevations indicated on the right vertical axis in Figure 4A are referenced to the existing ground surface elevation near soundings S-1 and S-2 (i.e., approximately +5 feet). The elevations were not directly surveyed and were interpolated based on the provided topographic map. Pile lengths should be determined based on the design axial load and pile tip elevation relationship provided in Figure 4A, and the actual pile-top cut off elevations.

An ASD safety factor of 2.0 was applied to the estimated ultimate pile bearing resistances to determine the allowable compressive load and a safety factor of 3.0 was applied to determine allowable tension loads from a geotechnical resistance standpoint. Load testing must be implemented to use the safety factor of 2.0 assumed in our analysis.

The piles should be installed to a minimum pile tip elevation of -25 feet, (i.e., approximately 30 feet below the existing grade elevation of +5 feet), to penetrate soft to stiff clay layers encountered at some test locations. An efficiency factor accounting for capacity reductions caused by group effects of 1.0 should be used for center-to-center pile spacing of three pile diameters or more. Three pile diameters is the minimum recommended spacing for piles.

As illustrated in Figure 4A, a 14-inch diameter ACIP pile properly installed to a tip elevation of -25 feet is estimated to provide an allowable axial compressive resistance of 106 kips (53 tons), based on a safety factor of 2.0, and confirmation by load testing. An allowable axial tension resistance of 52 kips (26 tons) is estimated based on a safety factor of 3.0.

Similarly, a 16-inch diameter ACIP pile properly installed to a tip elevation of -25 feet is estimated to provide an allowable axial compressive resistance of 134 kips (67 tons), based on a safety factor of 2.0, and confirmation by load testing. An allowable axial tension resistance of 60 kips (30 tons) is estimated based on a safety factor of 3.0.

The structural capacity of the piles has not been considered in our analysis and is the responsibility of the Structural Engineer.

5.2.2 *Geotechnical Lateral Pile Response*

The NCBC requires the allowable lateral load on a pile be determined by an approved method of analysis (or lateral load test) and the allowable load should be limited to one-half of the lateral load that produces a gross lateral movement of 1 inch at the lower of: 1) the top of the foundation element or 2) the ground surface. The code allows for higher deflections or loads to be used if the Structural Engineer can show that the predicted lateral movement and resulting load will cause neither harmful distortion or instability in the structure, nor cause any element to be loaded beyond its capacity.

Lateral loads and foundation details are not available at this time, so design-level lateral pile analyses cannot be performed. More specifically and as explained below, because lateral pile response depends on pile spacing and pile group geometries, it cannot be fully evaluated until these details are better defined. As a preliminary step, we used LPILE[1] to analyze the response of an individual pile, 30 feet in length, without consideration of any group effects. The lateral load that produces 1 inch of lateral movement at the pile head was computed, and the allowable lateral load was then defined as half of this value. The analysis was repeated with this allowable lateral load to compute the estimated lateral deflection, shear, and moment distributed along the length of the pile.

The single pile analysis modeled fixed head restraint conditions. Axial loads of 106 and 135, respectively, were applied to the top of the foundations as summarized in Table 5-2. Piles were modeled with a non-linear bending

1 Reese, Lymon C., Wang, Shin-Tower, LPILE 2022.12.10, Ensoft, Inc., 2022.

stiffness for 14-inch and 16-inch diameter piles, using a concrete strength of 4,000 psi and typical steel reinforcement patterns with steel to concrete ratios of approximately 1 ½ percent. A change in pile-top geometry relative to the ground surface, as well as the remaining modelling aspects can have a significant effect on pile response.

A summary of the lateral analyses is presented in Table 5-2, and plots of the deflection, shear, and moment versus depth for each pile type are included in the Appendix.

Table 5-2: Summary of Single Pile Lateral Response

Pile Type	Pile Top Conditions	Load Case	Applied Axial Load (kips)	Pile Head Lateral Deflection (in.)	Lateral Shear Load (kips)	Maximum Bending Moment (in.-kips)
14-inch Diameter ACIP	Fixed Head	1 in. Lateral Deflection	106	1.0	26.8	898
		Allowable Lateral Load		0.16	13.4	509
16-inch Diameter ACIP	Fixed Head	1 in. Lateral Deflection	135	1.0	36.7	1387
		Allowable Lateral Load		0.18	18.4	774

* Lateral response is for a single pile and does not consider softened response due to group effects.

The information presented in Table 5-2 represents the geotechnical lateral response of a single pile and does not consider the softened response due to group effects. The response of a pile in a group will vary from the response of a single, stand-alone pile, and this response is affected by a number of factors including number of piles in a group, the center-to-center pile spacing, and the arrangement of the piles within the group. These group effects must be considered when evaluating the lateral response of piles.

Although structural properties have been assumed, the structural capacity of a pile has not been considered in our lateral soil-structure analyses. As such, the shear and moments calculated with depth may exceed structural limits and must be evaluated by the Structural Engineer. The Structural Engineer should review boundary conditions to confirm the assumptions are compatible with foundation design. The Structural Engineer should also review pile interaction diagrams to confirm the load case (i.e., compression or tension) that controls the structural pile design and capacity. Design of the pile structure is the responsibility of the Structural Engineer.

5.2.3 *Embedment, Difficult Drilling Conditions, and Auger Refusal*

Based on the soils encountered during our exploration, we do not anticipate that auger refusal will be routinely encountered above the specified pile tip termination depth if the proper rig and drill are used; however, it is possible that isolated, very hard lenses could cause difficult drilling or auger refusal above the desired bearing depths at some locations.

It is important that the pile installer does not stop trying to advance the pile at the first encounter of dense materials. Therefore, the auger refusal criterion is recommended to be defined as an auger advancement rate of

less than 1 foot per minute for at least 10 minutes at the full down-crowd pressure of the drill tooling. These refusal criteria may need to be exceeded if the minimum embedment depth is not achieved on a particular pile.

In order to advance the piles through potential very dense soils to reach the desired termination depths, a strong rotary turntable will be required, as well as sharp reinforced cutting bits. We anticipate that a drilled pile that is advanced using reinforced cutting teeth should be able to advance to the desired penetration depth, since our drill rig (using a tri-cone roller bit) was able to advance through these dense materials. However, slow augering should be expected to occur within the bearing stratum, and the contractor should be prepared to spend extra time advancing the piles by grinding into these materials if necessary.

5.2.4 *ACIP Pile Construction Considerations*

ACIP pile elements do not allow for down-hole observation prior to casting. Therefore, strict quality control is required to verify adequate grout volumes, and to confirm theoretical diameters meet the specified requirements. Piles should be constructed in accordance with Publication No. FHWA-HIF-07-03 (Geotechnical Engineering Circular No. 8: Design and Construction of Continuous Flight Auger Piles) dated April 2007. A pile installation plan should be submitted by the contractor that addresses all aspects of construction including sequencing, tooling and excavation, grouting, and finishing.

The contractor should use electronic monitoring equipment to continuously record penetration depth and torque throughout installation. During extraction and grouting, the contractor should record the volume of grout placed as a function of depth, as well as the total volume per pile. The Geotechnical Engineer or their representative should monitor installation of production piles. During pile installation, the representative should record (as a minimum) pile tip elevations, pile locations, and grout volumes, ideally at 5-foot increments as well as total volume. The representative should also cast grout cubes for compressive strength testing (ASTM C109).

Grout should be installed using a positive displacement pump. The pump discharge capacity should be calibrated in order to adequately determine the quantity of grout installed. Grout should be pumped with sufficient pressure to prevent suction as the augers are withdrawn and avoid necking or collapse of the auger hole. We recommend that a pressure head of at least 10 feet of grout be maintained above the injection point. Auger hoisting equipment should be capable of removing the augers slowly while turning in a clockwise direction. The grout should be discharged at the tip of the auger and at a constant rate. To confirm that the grout is in good contact with the sidewalls of the auger hole and there has been no hole collapse, we recommend that the injected grout volume per linear foot be no less than 120 percent of the theoretical grout volume (volume of auger hole).

To establish production pile lengths and confirm the estimated capacities, we recommend at least one sacrificial ACIP pile be statically loaded to geotechnical failure using the ASTM D1143 quick loading procedure. The test pile should be installed using the same construction techniques (i.e., the same grout volume, tooling, etc.) planned for the production piles. The pile should be loaded to geotechnical failure or three times the design load, whichever occurs first. Load testing is considered part of the geotechnical design, and S&ME must provide technical oversight, observation, and evaluation of the static load test program.

If it is determined by the design team that it is desired to consider a higher tension resistance per pile, then it may also be appropriate to perform tension testing of one or more test piles in accordance with the quick loading procedure of ASTM D 3689 - "Standard Test Methods for Deep Foundations under Static Axial Tensile Load." In

this case, we would recommend that at least one static tension test be performed by the contractor on one pile that is constructed to the design dimensions and loaded to at least twice the design working tension single pile capacity to confirm that the assumed ultimate design strength is available. This test is typically setup and performed by the pile contractor using their equipment, and is observed by the Geotechnical Engineer

The installation of strain gages to determine the load distribution along the length of the test pile may be of benefit in evaluating the load test results and optimizing the required production pile length. S&ME can assist with determining appropriate strain gage locations if desired. If load testing has confirmed the pile achieved the required resistance, subsequent piles should be installed to similar bearing depths with similar techniques. Load testing may indicate that adjustments to lengths are necessary.

All ACIP pile installation should be observed by S&ME to confirm that the conditions encountered during excavation are consistent with the results of our geotechnical exploration and the assumptions of our geotechnical analysis. If the actual conditions at specific pile locations vary significantly from the conditions used in our geotechnical analysis, then adjustments to the pile length may be necessary.

5.3 Micropiles

We understand that micropiles may be considered for foundation support of the new Touch Tank to be constructed in the existing building due to height restrictions within the existing building or other factors. The preliminary recommendations presented herein are for conceptual purposes, in part since our exploration did not include a test location within the Touch Tank footprint.

Micropiles are small diameter piles (i.e., generally less than 12 inches) that are typically drilled and grouted in place with neat cement. They can be installed with small, relatively low-impact equipment and are commonly used in underpinning and/or remediation applications where they are installed immediately adjacent to, or drilled through, existing foundations. They can efficiently support relatively large axial loads and can also support modest lateral loads. The top of the pile is often cased to improve lateral performance.

Micropiles are installed by specialty contractors using a relatively wide variety of means and methods. A commonly used system in the Wilmington area is a "hollow bar" micropile. As the name implies, these foundation elements are constructed using a hollow steel bar attached to a sacrificial drill bit. The bars are drilled into the ground using a mud-rotary method with lean grout serving as the drilling mud. At the target depth, drilling stops, and the lean grout is flushed and replaced with the design-strength grout. The hollow bar serves as the structural member and is incorporated into a cap at the surface, typically by means of a bearing plate and nuts at the top of the hollow bar.

A variety of other micropile systems are also used, each with certain advantages. For example, as compared to the hollow bar system, some alternate methods are better suited for higher capacity elements, difficult drilling conditions, or a reduced volume of spoils. The primary differences are the materials that are used (e.g., hollow bars, solid bars, casing, etc.), the capabilities of the drilling equipment (e.g., rotary, rotary-percussion, duplex, etc.), and the grouting methodology (e.g., gravity, pressure, post-grouted, etc.).

5.3.1 *Procurement*

Micropiles are often proprietary and provided on a design-build basis by specialty contractors. As such, we recommend micropiles be procured using a performance specification. In general, the performance specification should include the following:

- The allowable axial loads that the piles will support with the required factor of safety (typically 2 when the recommended static load testing is performed).
- The allowable lateral loads that the piles will support (if any).
- The static load testing requirements – for this project, we recommend a minimum of 1 static load test be performed.
- Minimum pile length of 20-ft below pile cap.
- A pile design and installation plan submittal – the submittal should include the design calculations, the proposed means and methods, and the contractor's QC plan. The submittal should also address how the contractor will make sure that existing foundations are not undermined or heaved during pile installation.

A copy of our geotechnical report should be submitted to the design-build contractor to provide the necessary subsurface data for the design. We should also be provided with the opportunity to review the contractor's submittal.

5.3.2 *Axial Pile Resistance*

We have not been provided service loads anticipated to be required for micropiles. For preliminary conceptual purposes, we have evaluated axial resistances versus depth for individual 8-inch diameter micropiles based on the subsurface conditions encountered in our CPT soundings. Figure 4B of Appendix I presents a plot of the estimated single-pile allowable axial resistances.

An ASD safety factor of 2.0 was applied to the predicted ultimate soil resistances to determine the allowable geotechnical resistance. Load testing must be implemented to use the safety factor of 2.0 assumed in our analyses. The allowable tension resistance for the micropiles was estimated using a safety factor of 3.0.

As previously noted for ACIP piles, based on the sounding data, we recommend piles be installed to a minimum pile tip elevation of -25 feet, (i.e., approximately 30 feet below the existing grade elevation of +5 feet), to penetrate soft to stiff clay layers encountered at some test locations.

As illustrated in Figure 4B, an 8-inch diameter micropile properly installed to a tip elevation of -25 feet is estimated to provide an allowable axial compressive resistance of 54 kips (27 tons), based on a safety factor of 2.0, and confirmation by load testing. An allowable axial tension resistance of 30 kips (15 tons) is estimated based on a safety factor of 3.0.

Because the performance of micropiles is dependent on installation methods, our estimates are provided for conceptual planning only. The foundation contractor should be responsible for determining what penetration and diameter is required for their design and specific means and methods.

5.4 Shallow Foundations

The following section provides shallow foundation recommendations for the new single-story generator and electrical building and elevated single-story mechanical structure planned for construction on the south and southeast sides of the existing building.

Provided that the recommendations which follow in this report for site preparation and fill placement and compaction are implemented, the structure can be supported on shallow spread footings bearing in compacted structural fill or suitable natural soils and designed for a net allowable bearing pressure of up to 3,000 pounds per square foot (psf). Based on encountered subsurface conditions, assumed structural loads, and assuming the subgrades are properly prepared as discussed herein, we estimate that total settlement of building foundations will be 1 inch or less with differential settlements of about ½ inch or less.

Footings should bear at least 18 inches below exterior grade so they will not be adversely affected by frost penetration and to develop the design bearing capacity. Continuous wall footings should be at least 18 inches wide, and isolated column footings should be at least 24 inches wide. This recommendation is made to prevent a localized or "punching" shear failure condition which can occur with very narrow footings.

The bottom of all footing excavations for the structure should be evaluated by the S&ME geotechnical engineer or their representative using a hand auger and dynamic cone penetrometer (DCP). In cases where the DCP testing indicates insufficient available bearing pressure for the applied bearing pressure, the foundation bearing soils may need to be repaired. Repairs may include undercutting and replacing with washed stone (#57) prior to foundation construction, subject to the recommendations of the geotechnical engineer.

It should be anticipated that where footings bear directly on fill, or within loose native soils, the soils exposed in the bottom of the footings may need to be tamped to increase their density prior to the placement of foundation concrete.

5.5 Floor Slabs

The following recommendations are provided regarding thin grade slabs subjected to relatively light area loads of 150 psf, or less, and structurally separated from column and wall loads. These recommendations are not intended to be applicable to structural slabs.

A slab-on-grade floor system can be adequately supported on newly placed and compacted structural fill or approved natural soils, provided the site preparation and fill placement procedures outlined in this report are implemented.

We recommend that at least 6 inches of compacted select granular material be placed beneath all ground floor slabs to provide a capillary break, provide more uniform slab support, and reduce damage to subgrade soils during construction. The select granular fill should classify as SP, SP-SM, SW, or SW-SM in accordance with the Unified Soil Classification System, which requires that these soils have less than 12 percent passing the No. 200 sieve. Manufactured materials such as aggregate base course (ABC) or processed fill (i.e., screenings) meeting this specification can be used. A modulus of subgrade reaction value of 175 psi/in may be used to design floor slab

on subgrades consisting of these soils compacted to at least 98 percent of the soil's standard Proctor maximum dry density.

Exposure to the environment and construction activities will weaken the floor slab subgrade soils. Therefore, we recommend that subgrade soils in slab areas be evaluated prior to placement of the select granular fill. If near surface deterioration of the soils has occurred, undercutting or reworking of the fill may be necessary.

Water vapor transmission through the slab is a design consideration. Evaluating the need for and design of a vapor retarder or vapor barrier for moisture control is outside our scope of services and should be determined by the project architect/structural engineer based on the planned floor coverings and the corresponding design constraints, as outlined in ACI 302.1R-04 Guide for Concrete Floor and Slab Construction. Further, health and environmental considerations with respect to any potentially harmful vapor transmission are also outside of our scope.

5.6 Lateral Earth Pressure Coefficients

The lateral earth pressure coefficients given below in Table 5-3 may be used to design below-grade earth retaining structures, such as pile caps, cast neat into native soil excavations or properly backfilled. The values given in the following table assume that any backfill that is placed around and behind these structures is placed and compacted in accordance with the requirements of Section 5.7.5 of this report. These values assume backfill generally classified as SP or SM, soils according to the Unified Soil Classification system.

Table 5-3: Lateral Earth Pressure Coefficients

Support Condition	Angle of Internal Friction (φ')	Cohesion (lbs./sq.ft.)	Moist Unit Weight (γ)	Drained Static Earth Pressure Coefficient (K)
Active (K_a)	30	0	120	0.33
At-Rest (K_o)	30	0	120	0.50
Passive (K_p)	30	0	120	3.0

A. The above values represent a fully-drained soil condition at or near the optimum moisture content. Where backfill soils are not fully drained, the lateral soil pressure must consider hydrostatic forces below the water level, and submerged soil unit weight.
B. A coefficient of sliding friction (tan δ) of 0.36 may be used in computation of the lateral sliding resistance.

We have not been provided details regarding the location or height of any earth retaining walls. Note that any basement or loading dock wall which is backfilled prior to being braced internally by framing must, in addition to being designed as a fully braced wall using the at-rest earth pressure, also be designed to resist the lateral earth pressure for the active case as a fully cantilevered wall.

Organic soils (OL or OH), inorganic silts (ML or MH), or inorganic plastic clays (CL or CH) soils should not be used as retaining wall backfill.

Compact the backfill directly behind walls with light, hand-held compactors. Heavy compactors and grading equipment should not be allowed to operate within 5 feet of the walls during backfilling to avoid developing excessive temporary or long-term lateral soil pressures. We caution that operating compaction equipment directly behind the retaining structures can create lateral earth pressures far in excess of those recommended for design. Therefore, bracing of the walls may be needed during backfilling operations.

Provide positive gravity drainage of the backfill using a permanent toe drain to limit buildup of hydrostatic pressures in the backfill. Gravity drainage may consist of a minimum two-foot-wide blanket of clean crushed stone or washed sand, separated from the backfill by a properly graded filter or approved non-woven geotextile filter fabric, or equivalent. Vertical drains should be tied into a permanent "toe" drain installed at the base of the wall. Where gravity drainage of retaining walls is not feasible, design walls to resist hydrostatic forces in addition to the lateral earth pressure.

5.7 Earthwork

To reduce potential earthwork problems, site preparation and grading should be scheduled during the typically drier months of May through November, if possible. If late fall or winter grading is attempted, repair of near-surface soils and possible use of select off-site borrow will be necessary to adequately prepare subgrades for new construction. Heavy rubber-tired construction equipment should not be allowed to operate on exposed subgrades during wet conditions. Even during drier periods of the year, we recommend that exposed subgrades be sloped and sealed at the end of each day to promote runoff and reduce infiltration from rainfall. Water should not be allowed to pond on exposed subgrades. To further reduce potential deterioration of exposed subgrades, construction traffic patterns should be managed to limit equipment passes across the site.

The following sections present our geotechnical recommendations regarding earthwork.

5.7.1 Demolition of Previous Construction

The following general recommendations are provided for the demolition of any underground utilities, old foundations, and/or previous construction remnants where encountered:

1. Demolish existing pavements and existing structures within the footprint of proposed new structures.
2. Following demolition of the existing pavements and structures, remove or plug existing utilities that are to be permanently abandoned. If not removed or plugged, pipes may serve as conduits for subsurface erosion resulting in formation of voids below foundations or grade slabs.
3. Reroute existing utilities that will remain in use around the proposed building footprints.
4. Areas excavated to remove any buried structures should be backfilled in accordance with Section 5.7.5 of this report.
5. As with any demolition project, there may be unexpected or unforeseen conditions encountered in the subsurface. In such cases, the Geotechnical Engineer should be consulted.

5.7.2 Site Preparation

Prior to construction, site drainage improvements should be implemented for existing drainage features and new drainage ditching established to lower shallow water levels or perched water and divert water away from the

construction area. Drainage should be maintained throughout construction. Surface and subsurface water conditions that occur during construction will determine the need for and extent of drainage measures. Water levels should be lowered and/or maintained 2 feet or more beneath existing grades within the construction area.

After site drainage is established, site preparation should be initiated by clearing vegetation and stripping and grubbing of organics and topsoil, and any other deleterious materials for a lateral distance of at least 5 feet beyond the limits of new construction. Although appreciable surficial topsoil was not encountered within the hand auger borings, stripping of surficial vegetation and organic materials will be necessary and may be deeper in the wooded and low-lying areas. The site should be stripped with light, tracked equipment to avoid mixing the topsoil into the loose near surface silty sands and creating thicker stripping depths.

Very loose to loose near-surface sands were encountered at most of the test locations. After the stripping operation is complete and temporary site drainage has been installed, for areas to receive fill or near final grades, the exposed soil surface should be thoroughly densified in place by making several passes with a heavy vibratory roller prior to placement of new fill or beginning the next stage of construction. Moisture conditioning of the subgrade by the addition of water or drying of soils may be required prior to densification, depending upon conditions at the time of construction. Soils may need to be plowed or disced and dried (or in some cases wetted) to adjust the moisture content to suitable levels for compaction.

Following densification, but prior to fill placement, the exposed surfaces of areas to receive fill and areas near final grades should be evaluated by an S&ME geotechnical engineer or their representative. This evaluation should include proofrolling with a fully-loaded tandem-axle dump truck or similar rubber-tired construction equipment. Any areas that deflect excessively and cannot be densified by rolling should be repaired by undercutting to suitable soils and replacing with compacted structural fill or aggregate base course (ABC) stone. Densification or undercutting existing near-surface soils may be required depending on weather conditions at the time of construction.

5.7.3 *Subgrade Repair and Improvement Methods*

The exposed subgrade of both cut and fill areas can deteriorate and lose support when exposed to construction traffic and adverse weather conditions. Deterioration can occur in the form of rutting, pumping, freezing, or erosion. We recommend that, during construction, exposed subgrade surfaces be sealed at the end of each day or when wet weather is forecast. Water should not be allowed to pond in fill or cut areas. Immediately prior to foundation or floor slab construction, exposed subgrade soils should be evaluated. Evaluation by proofrolling should be conducted where practical to determine their stability. Soils which rut, pump, or deflect under proofrolling should be repaired prior to granular soil or ABC stone placement. Repair measures may include scarifying/drying/recompacting, undercutting, placement of geotextiles, or some combination of these. Actual repair measures will be influenced by project schedule and weather conditions and can only be determined in the field.

5.7.4 *Excavations*

Based on subsurface conditions encountered and assumed site grading, medium dense to dense silty sands will be encountered within anticipated shallow excavation depths at the site. Local excavations within these materials

for shallow utility trenches and foundations can be accomplished by a conventional backhoe or track-mounted backhoe.

Soils encountered during our exploration within the anticipated excavation depths for the project appear suitable for re-use as structural fill. Sandy soils borrowed from below water levels or in areas of perched water may be significantly wet of the optimum moisture content for compaction and may need to be stockpiled and allowed to drain, and/or rigorously worked.

The contractor should be prepared to dewater where utility or foundation excavations extend beneath subsurface water levels and control any water that collects in excavations. Temporary ditches or the use of French drains may be needed to assist in dewatering the site for construction. The contractor should be responsible for determining water control measures.

Excavations should be sloped or shored in accordance with local, state, and federal regulations, including OSHA (29 CFR Part 1926) excavation trench safety standards. The contractor is usually responsible for site safety. This information is provided only as a service and under no circumstances should we be assumed responsible for construction site safety.

5.7.5 *Structural Fill Placement and Compaction*

Soils used as structural fill should meet the following requirements:

- USCS classification of SM, SC, SP, SW, or some combination of these.
- Plasticity index of 10 percent or less.
- Contain less than 3 percent organics.
- Be free of trash or other deleterious materials.
- Have a maximum particle size of 2 inches or less.
- Have a minimum standard Proctor maximum dry density of 100 pounds per cubic foot.

All new structural fill soil should be placed in 8 to 10-inch loose lifts and compacted to at least 95 percent of the standard Proctor maximum dry density (MDD) (ASTM D698). The top 12 inches should be compacted to at least 98 percent of the materials standard Proctor MDD. The moisture content of structural fill should be maintained at +/- 3% of optimum moisture during compaction. S&ME construction services personnel, working under the supervision of the geotechnical engineer, should observe fill placement and compaction. An appropriate number of soil density tests should be conducted to confirm that adequate fill compaction is achieved.

Where present, water levels should be maintained at least 2 feet below any surface to be densified prior to beginning compaction. This is to prevent the compaction operation from drawing water up to the surface and degrading it. Compacted soils should not exhibit pumping or rutting under equipment traffic.

6.0 Limitations Of Report

This report has been prepared in accordance with generally accepted geotechnical engineering practice for specific application to this project. The conclusions and recommendations in this report are based on the

applicable standards of our practice in this geographic area at the time this report was prepared. No other warranty, express or implied, is made.

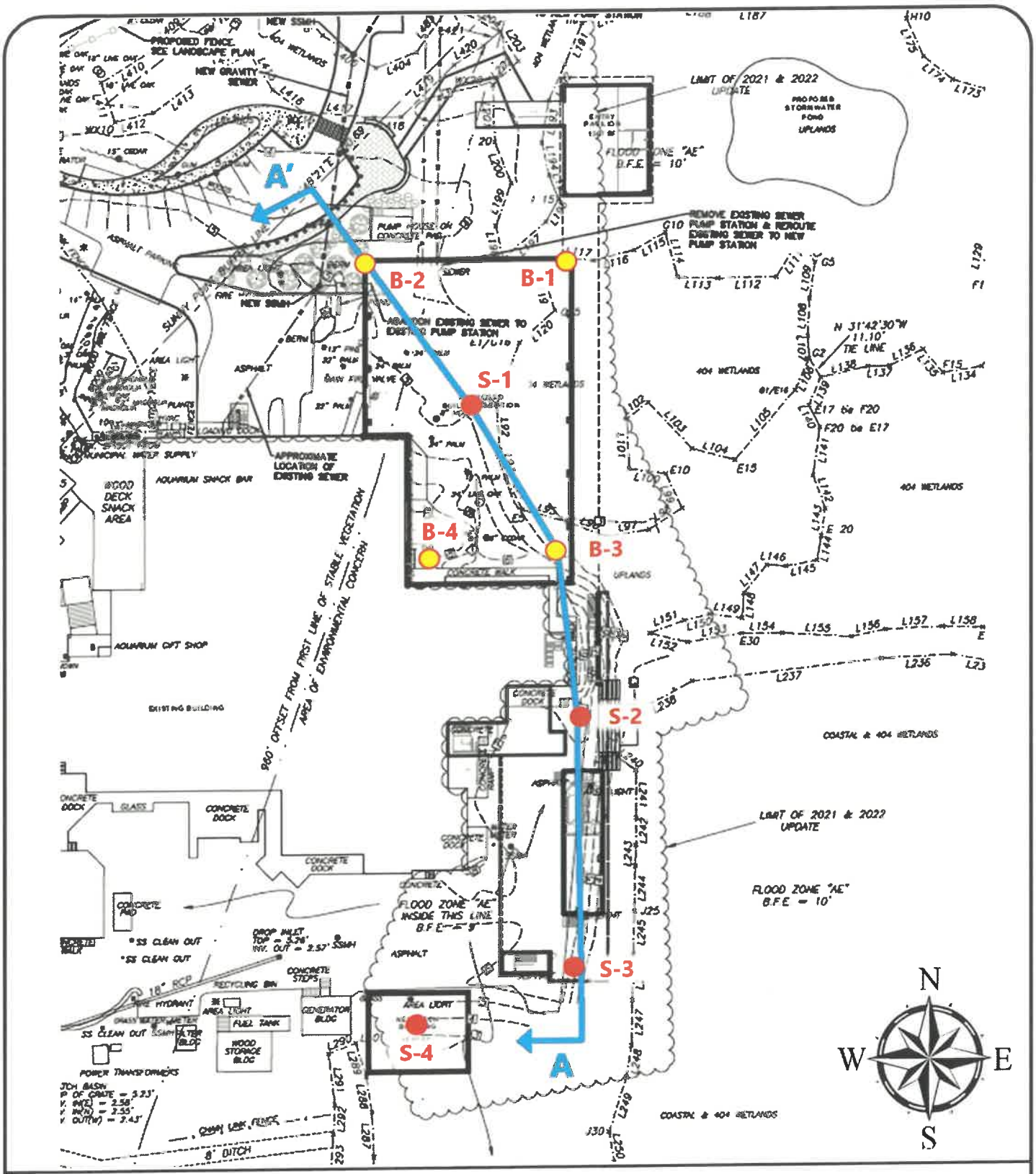
The analyses and recommendations submitted herein are based, in part, upon the data obtained from the subsurface exploration. The nature and extent of variations of the soils at the site to those encountered at our boring locations may not become evident until construction. If variations appear evident, then we should be provided the opportunity to re-evaluate the recommendations of this report. In the event that any changes in the nature, design, or location of the structure are planned, the conclusions and recommendations contained in this report will not be considered valid unless the changes are reviewed and conclusions modified or verified in writing by the submitting engineers.

Assessment of site environmental conditions; sampling of soils, ground water or other materials for environmental contaminants; identification of jurisdictional wetlands, rare or endangered species, geological hazards or potential air quality and noise impacts were beyond the scope of this geotechnical exploration.

S&ME should be provided the opportunity to review the final plans and specifications to confirm that our recommendations are properly interpreted and implemented. The recommendations in this report are contingent on S&ME's review of final plans and specifications followed by observation and monitoring during construction.

Appendices

Appendix I – Figures



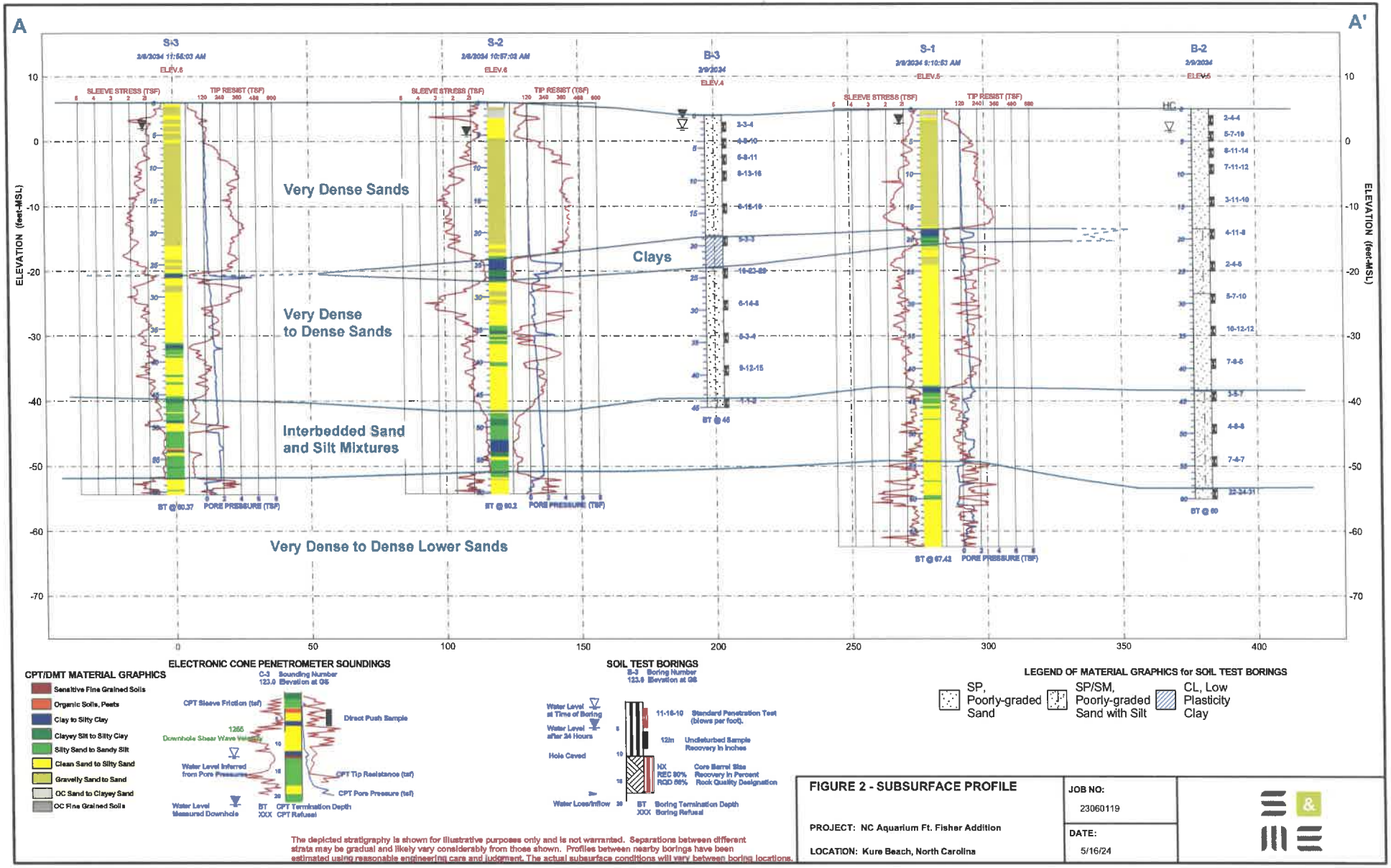
Legend

- = CPT Sounding
- = SPT Boring

Test Location Sketch

Fort Fisher Aquarium Expansion
Fort Fisher, North Carolina

SCALE:	AS SHOWN
DATE:	5/16/2024
PROJECT NO:.	23060119
FIGURE NO.	1



ELECTRONIC CONE PENETROMETER SOUNDINGS

CPT/DMT MATERIAL GRAPHICS

- Sensitive Fine Grained Soils
- Organic Soils, Peats
- Clay to Silty Clay
- Clayey Silt to Silty Clay
- Silty Sand to Sandy Silt
- Clean Sand to Silty Sand
- Gravelly Sand to Sand
- OC Sand to Clayey Sand
- OC Fine Grained Soils

SOIL TEST BORINGS

LEGEND OF MATERIAL GRAPHICS for SOIL TEST BORINGS

SP, Poorly-graded Sand | SP/SM, Poorly-graded Sand with Silt | CL, Low Plasticity Clay

The depicted stratigraphy is shown for illustrative purposes only and is not warranted. Separations between different strata may be gradual and likely vary considerably from those shown. Profiles between nearby borings have been estimated using reasonable engineering care and judgment. The actual subsurface conditions will vary between boring locations.

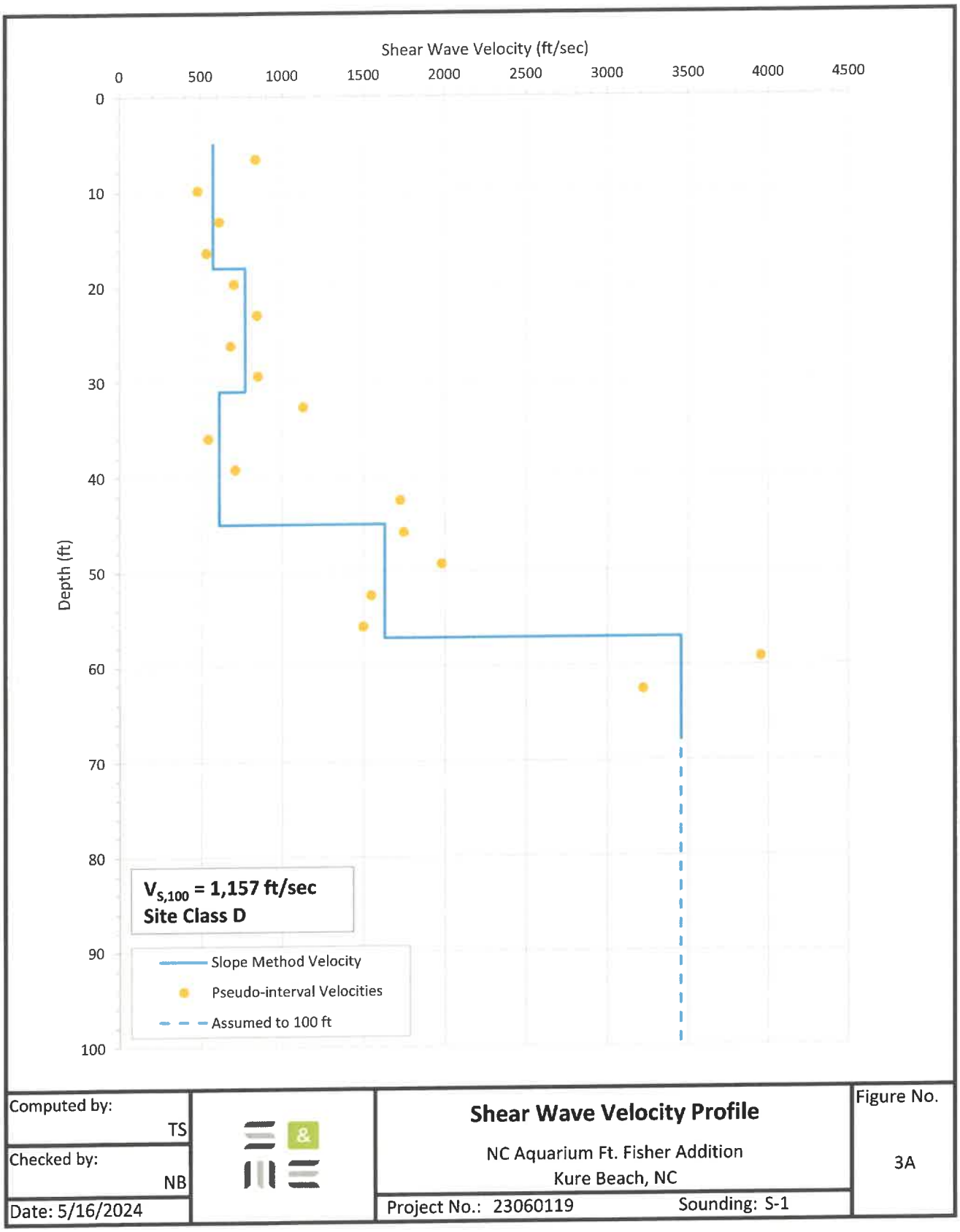
FIGURE 2 - SUBSURFACE PROFILE

PROJECT: NC Aquarium Ft. Fisher Addition

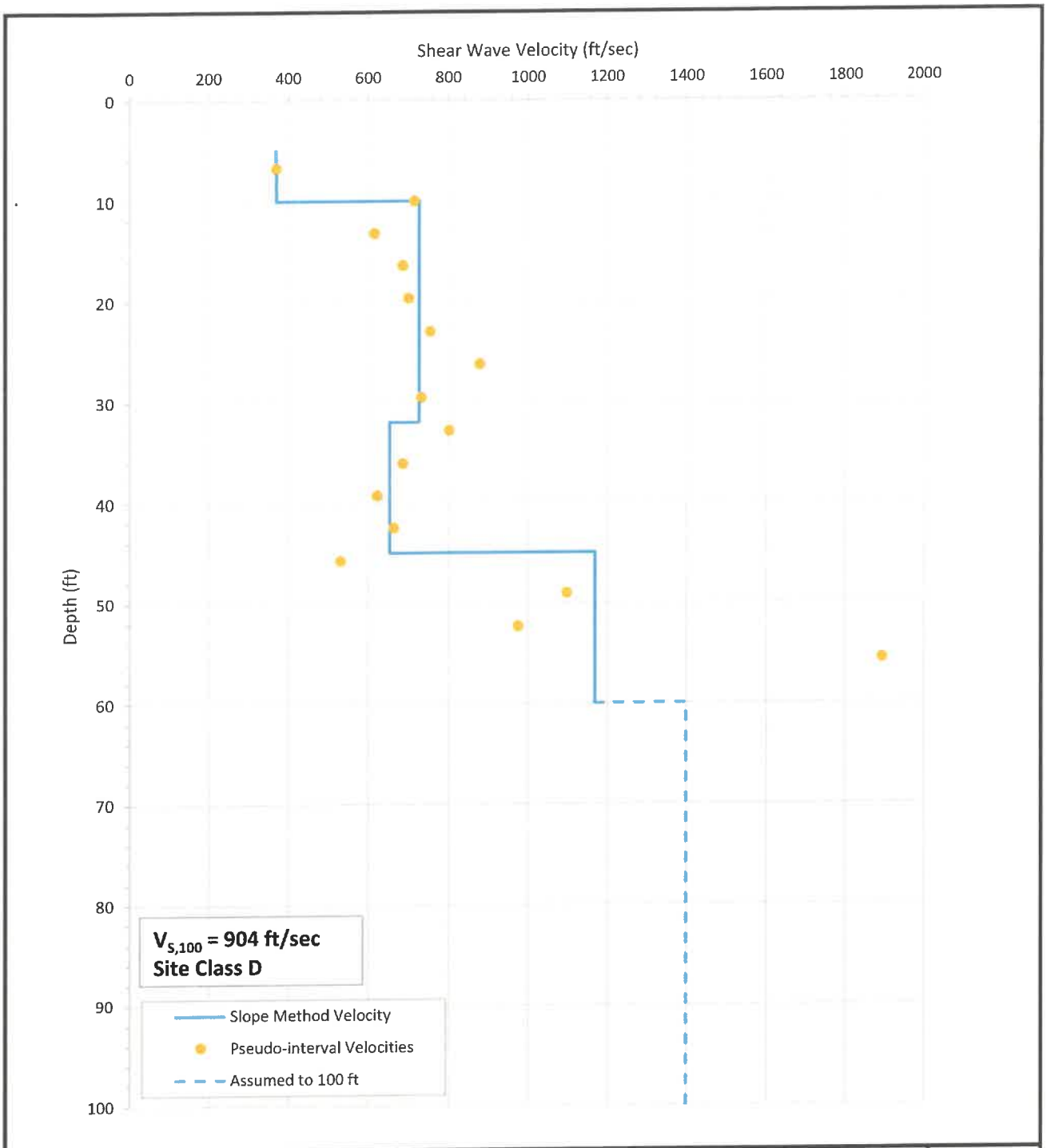
LOCATION: Kure Beach, North Carolina

JOB NO: 23060119

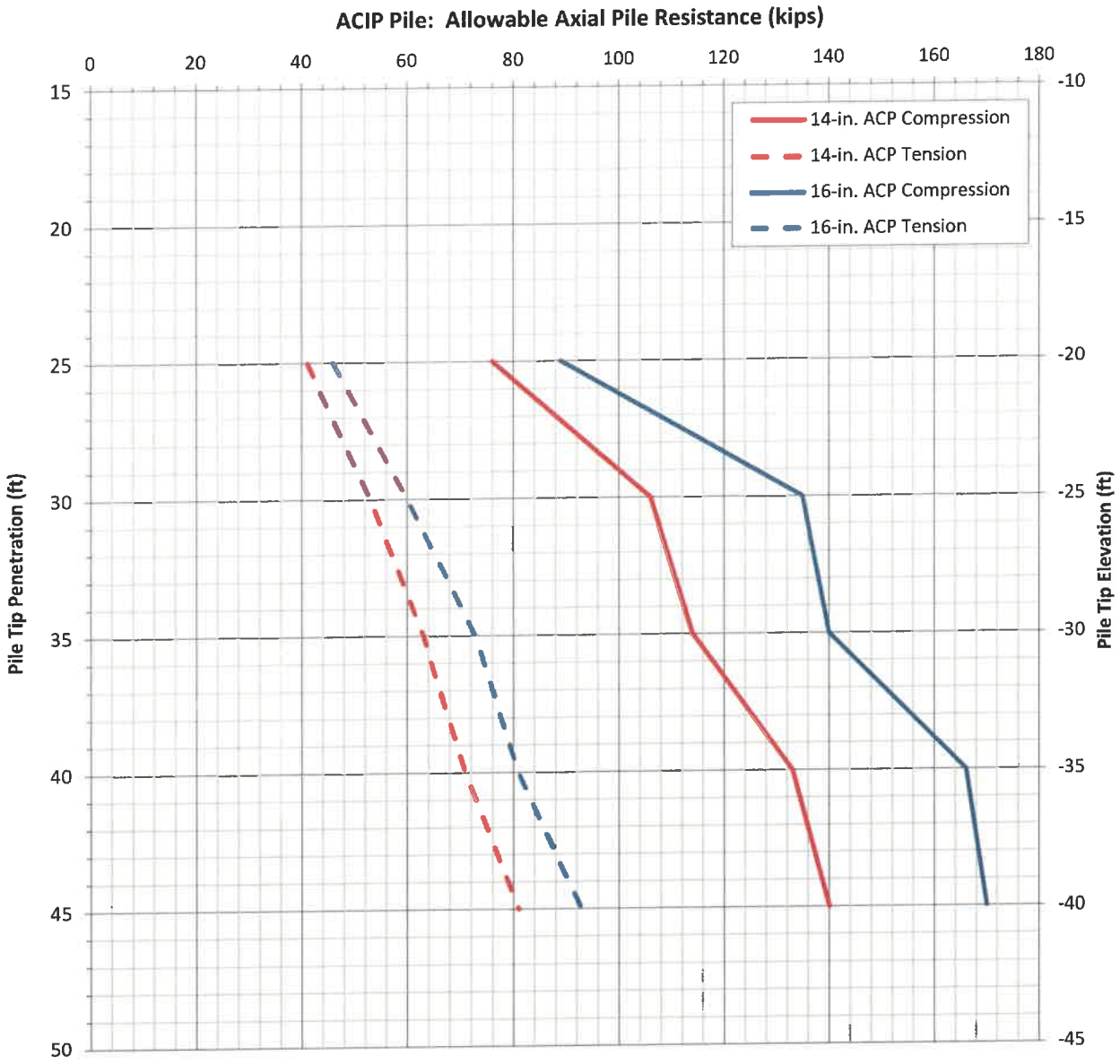
DATE: 5/16/24



Computed by: TS		**Shear Wave Velocity Profile**	Figure No.
Checked by: NB		NC Aquarium Ft. Fisher Addition Kure Beach, NC	3A
Date: 5/16/2024		Project No.: 23060119 Sounding: S-1	



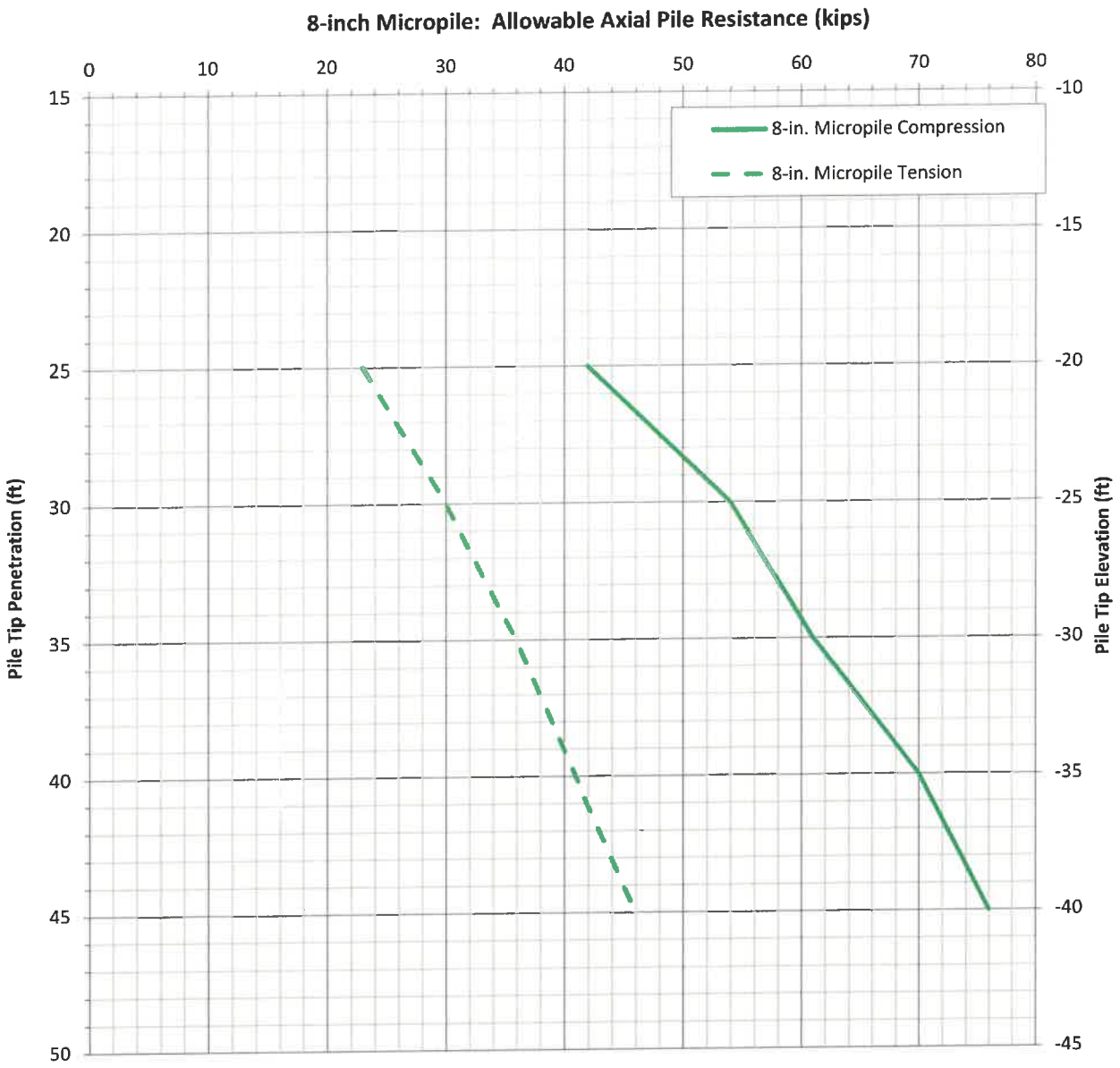
Computed by: TS		**Shear Wave Velocity Profile**	Figure No.
Checked by: NB		NC Aquarium Ft. Fisher Addition Kure Beach, NC	3B
Date: 5/16/2024		Project No.: 23060119 Sounding: S-3	



NOTES:

1) Resistance values presented are allowable values calculated using an ASD safety factor of 2.0 for compression and 3.0 for tension. Load testing is required for a saftey factor of 2.0. See report for additional discussion.
2) The allowawable axial loads are based on the estimated geotechnical resistance. The structural capacity of the piles has not been considered in our analysis and is the responsibility of the project structural engineer.
3) An efficiency factor to account for capacity reductions caused by group effects of 1.0 should be used for center to center pile spacings of three pile diameters or more. Three pile diameters is the minimum recommended spacing.
4) Recommended minimum pile tip elevation is -25 ft, based on an existing ground surface elevation of 5 ft.

	ACIP Pile: Allowable Axial Pile Resistance		Figure No.
	N.C. Aquarium Ft. Fisher Addition	Project No: 23060119	4A
	Kure Beach, North Carolina	Date: 5/16/2024	



NOTES:

1) Resistance values presented are allowable values calculated using an ASD safety factor of 2.0 for compression and 3.0 for tension. Load testing is required for a saftey factor of 2.0. See report for additional discussion.
2) The allowawable axial loads are based on the estimated geotechnical resistance. The structural capacity of the piles has not been considered in our analysis and is the responsibility of the project structural engineer.
3) An efficiency factor to account for capacity reductions caused by group effects of 1.0 should be used for center to center pile spacings of three pile diameters or more. Three pile diameters is the minimum recommended spacing.
4) Recommended minimum pile tip elevation is -25 ft, based on an existing ground surface elevation of 5 ft.

	Micropile: Allowable Axial Pile Resistance		Figure No.
	N.C. Aquarium Ft. Fisher Addition	Project No: 23060119	4B
	Kure Beach, North Carolina	Date: 5/16/2024	

Appendix II – Exploration Procedures, Legends, and Logs

Summary of Exploration Procedures

The American Society for Testing and Materials (ASTM) publishes standard methods to explore soil, rock and ground water conditions in Practice D 420-18, *"Standard Guide for Site Characterization for Engineering Design and Construction Purposes."* The boring and sampling plan must consider the geologic or topographic setting. It must consider the proposed construction. It must also allow for the background, training, and experience of the geotechnical engineer. While the scope and extent of the exploration may vary with the objectives of the client, each exploration includes the following key tasks:

- Reconnaissance of the Project Area
- Preparation of Exploration Plan
- Layout and Access to Field Sampling Locations
- Field Sampling and Testing of Earth Materials
- Laboratory Evaluation of Recovered Field Samples
- Evaluation of Subsurface Conditions

The standard methods do not apply to all conditions or to every site. Nor do they replace education and experience, which together make up engineering judgment. Finally, ASTM D 420 does not apply to environmental investigations.

Reconnaissance of the Project Area

We walked over the site to note land use, topography, ground cover, and surface drainage. We observed general access to proposed sampling points and noted any existing structures.

Checks for Hazardous Conditions - State law requires that we notify North Carolina 811 (NC 811) before we drill or excavate at any site. NC 811 is operated by the major water, sewer, electrical, telephone, CATV, and natural gas suppliers of North Carolina. NC 811 forwarded our location request to the participating utilities. Location crews then marked buried lines with paint or colored flags within 72 hours. They did not mark utility lines beyond junction boxes or meters. We checked proposed sampling points for conflicts with marked utilities, overhead power lines, tree limbs, or man-made structures during the site walkover.

Additionally, we engaged a private utility locator subconsultant to locate and mark private utilities in the work area. Typically, the locator utilizes a combination of ground penetrating radar (GPR) and radio-frequency electromagnetic (EM) pipe and cable locators to scan the vicinity of test locations.

Field Sampling and Testing

Electronic Cone Penetrometer (CPT) Soundings

CPT soundings consist of a conical pointed penetrometer which is hydraulically pushed into the soil at a slow, measured rate. Procedures for measurement of the tip resistance and side friction resistance to push generally follow those described by ASTM D-5778, *"Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils."*

A penetrometer with a conical tip having a 60-degree apex angle and a cone base area of 10 cm^2 was advanced into the soil at a constant rate of 20 mm/s. The force on the conical point required to penetrate the soil was measured electronically every 50 mm penetration to obtain the *cone resistance* q_c. A friction sleeve is present on the penetrometer immediately behind the cone tip. The force exerted on the sleeve was measured electronically at a minimum of every 50 mm penetration and divided by the surface area of the sleeve to obtain the *friction sleeve resistance value,* f_s. A pore pressure element mounted immediately behind the cone tip was used to measure the pore pressure induced during advancement of the cone into the soil.

CPT Soil Stratification

Using ASTM D-5778 soil samples are not obtained. Soil classification was made on the basis of comparison of the tip resistance, sleeve resistance and pore pressure values to values measured at other locations in known soil types, using experience with similar soils and exercising engineering judgment.

Plots of normalized tip resistance versus friction ratio and normalized tip resistance versus penetration pore pressure were used to determine soil classification (Soil Behavior Type, SBT) as a function of depth using empirical charts developed by P.K. Robertson (1990). The friction ratio soil classification is determined from the chart in the appendix using the normalized corrected tip stress and the normalized corrected tip stress and the normalized friction ratio.

At some depths, the CPT data fell outside of the range of the classification chart. When this occurred, no data was plotted, and a break was shown in the classification profile. This occasionally occurred at the top of a penetration as the effective vertical stress is very small and commonly produced normalized tip resistances greater than 1000.

To provide a simplified soil stratigraphy for general interpretation and for comparison to standard boring logs, a statistical layering and classification system was applied to the field classification values. Layer thicknesses were determined based on the variability of the soil classification profile, based upon changes in the standard deviation of the SBT classification number with depth. The average SBT number was determined for each successive 6-inch layer, beginning at the surface. Whenever an additional 6-inch increment deviated from the previous increment, a new layer was started, otherwise, this material was added to the layer above and the next 6-inch section evaluated. The soil behavior type for the layer was determined by the mean value for the complete layer.

Downhole Shear Wave Velocity Test

Shear wave velocity measurements were performed using a cone penetrometer equipped with geophones, or a seismic cone penetrometer (SCPT). The seismic cone penetrometer measures the travel times of surface generated vibrations to geophones mounted on the penetrometer at various incremental depths in the sounding. At a given depth, the travel time of the first arrival is measured and corrected for the horizontal offset of the source at the surface from the sounding. Interval velocities are calculated by dividing the difference in travel times by the vertical distance between successive measurement depths. Measurements were made at 1-meter intervals – the length of commonly available CPT extension rods – unless otherwise noted.

Soil Test Boring with Mud Rotary Drilling

Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils". Rotary drilling processes were used to advance

the hole and a heavy drilling fluid was circulated in the bore holes to stabilize the sides and flush the cuttings. At regular intervals, drilling tools were removed, and soil samples were obtained with a standard 1.4 inch I. D., two-inch O. D., split barrel sampler. The sampler was first seated six inches to penetrate any loose cuttings, then driven an additional 12 inches with blows of a 140-pound hammer falling 30 inches. The number of hammer blows required to drive the sampler through the two final six-inch increments was recorded as the penetration resistance (SPT) N-value. The N-value, when properly interpreted by qualified professional staff, is an index of the soil strength and foundation support capability.

Hand Auger Borings without Dynamic Cone Penetrometer

Auger borings were advanced using hand operated augers. The soils encountered were identified in the field by cuttings brought to the surface. Representative samples of the cuttings were placed in glass jars or plastic bags and later transported to the laboratory. Soil consistency was qualitatively estimated by the relative difficulty of advancing the augers.

Water Level Measurement

Subsurface water levels in each sounding were measured via pore water pressure readings and corresponding depths from the existing grade. Subsurface water was measured from existing ground surface in the hand auger borings using a tape measure, where encountered.

CPT Soil Classification Legend

Zone	Q_t/N	Description
1	2	Sensitive, Fine Grained
2	1	Organic Soils-Peats
3	1.5	Clays-Clay to Silty Clay
4	2	Silt Mixtures-Clayey Silt to Silty Clay
5	3	Sand Mixtures-Silty Sand to Sandy Silt
6	4.5	Sands-Clean Sand to Silty Sand
7	6	Gravelly Sand to Sand
8	1	Very Stiff Clay to Clayey Sand*
9	2	Very Stiff, Fine Grained*

(*) Heavily Overconsolidated or Cemented

Robertson's Soil Behavior Type (SBT), 1990			
Group #	Description	Ic	
		Min	Max
1	Sensitive, fine grained	N/A	
2	Organic soils - peats	3.60	N/A
3	Clays - silty clay to clay	2.95	3.60
4	Silt mixtures - clayey silt to silty clay	2.60	2.95
5	Sand mixtures - silty sand to sandy silt	2.05	2.60
6	Sands - clean sand to silty sand	1.31	2.05
7	Gravelly sand to dense sand	N/A	1.31
8	Very stiff sand to clayey sand (High OCR or cemented)	N/A	
9	Very stiff, fine grained (High OCR or cemented)	N/A	

Soil behavior type is based on empirical data and may not be representative of soil classification based on plasticity and grain size distribution.

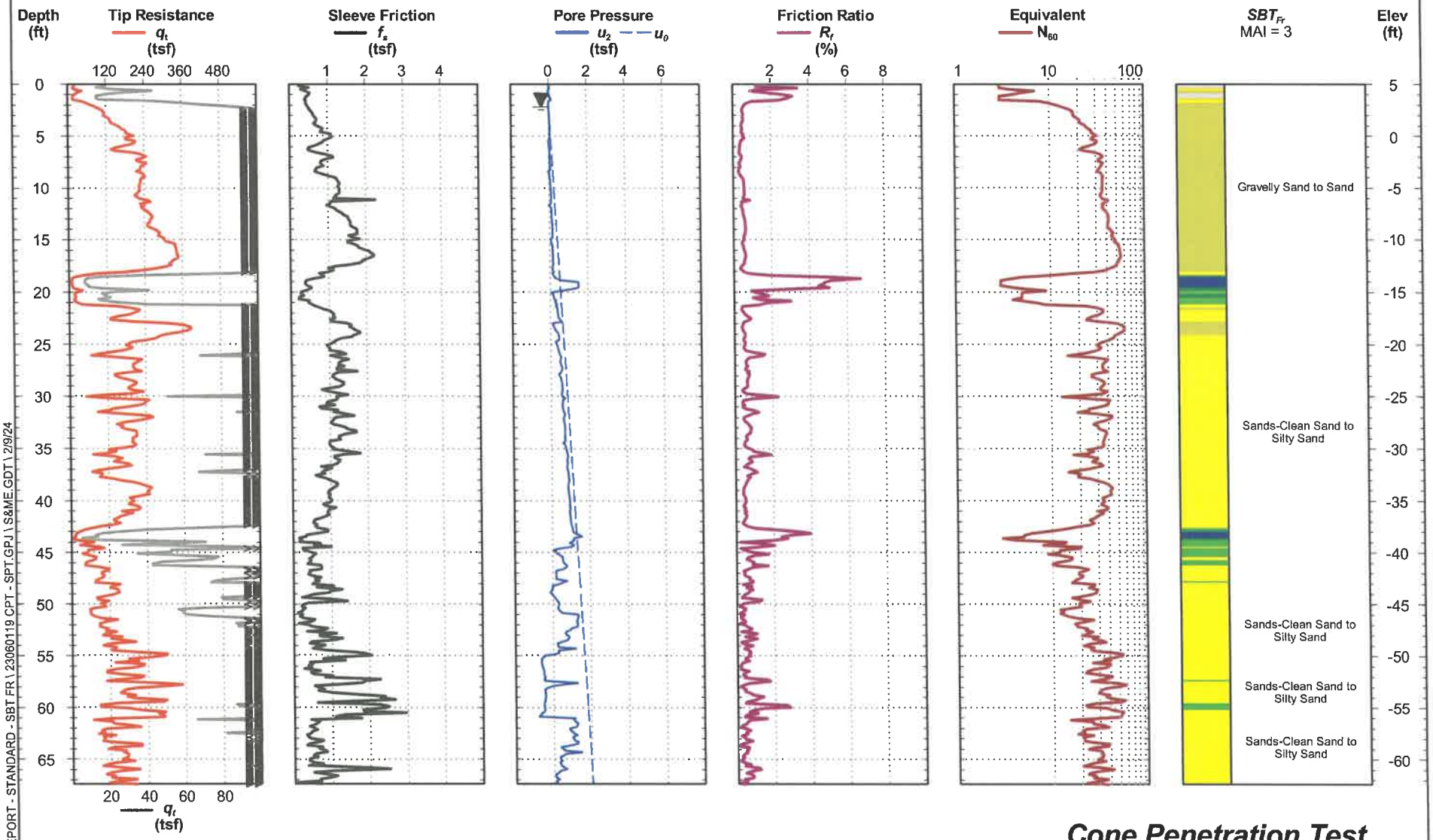
Relative Density and Consistency Table			
SANDS		SILTS and CLAYS	
Cone Tip Stress, qt (tsf)	Relative Density	Cone Tip Stress, qt (tsf)	Consistency
Less than 20	Very Loose	Less than 5	Very Soft
20 - 40	Loose	5 - 15	Soft to Firm
40 - 120	Medium Dense	15 - 30	Stiff
120 - 200	Dense	30 - 60	Very Stiff
Greater than 200	Very Dense	Greater than 60	Hard

Sounding ID: S-1

NC Aquarium Ft. Fisher Addition
Kure Beach, North Carolina
S&ME Project No: 23060119

Date: Feb. 8, 2024
Estimated Water Depth: 2.2 ft
Rig/Operator: Jared Duffy

Total Depth: 67.4 ft
Termination Criteria: Target Depth
Cone Size: 1.75



CPT REPORT - STANDARD - SBT FR \ 23060119 CPT - SPT.GPJ \ S&ME.GDT \ 2/9/24

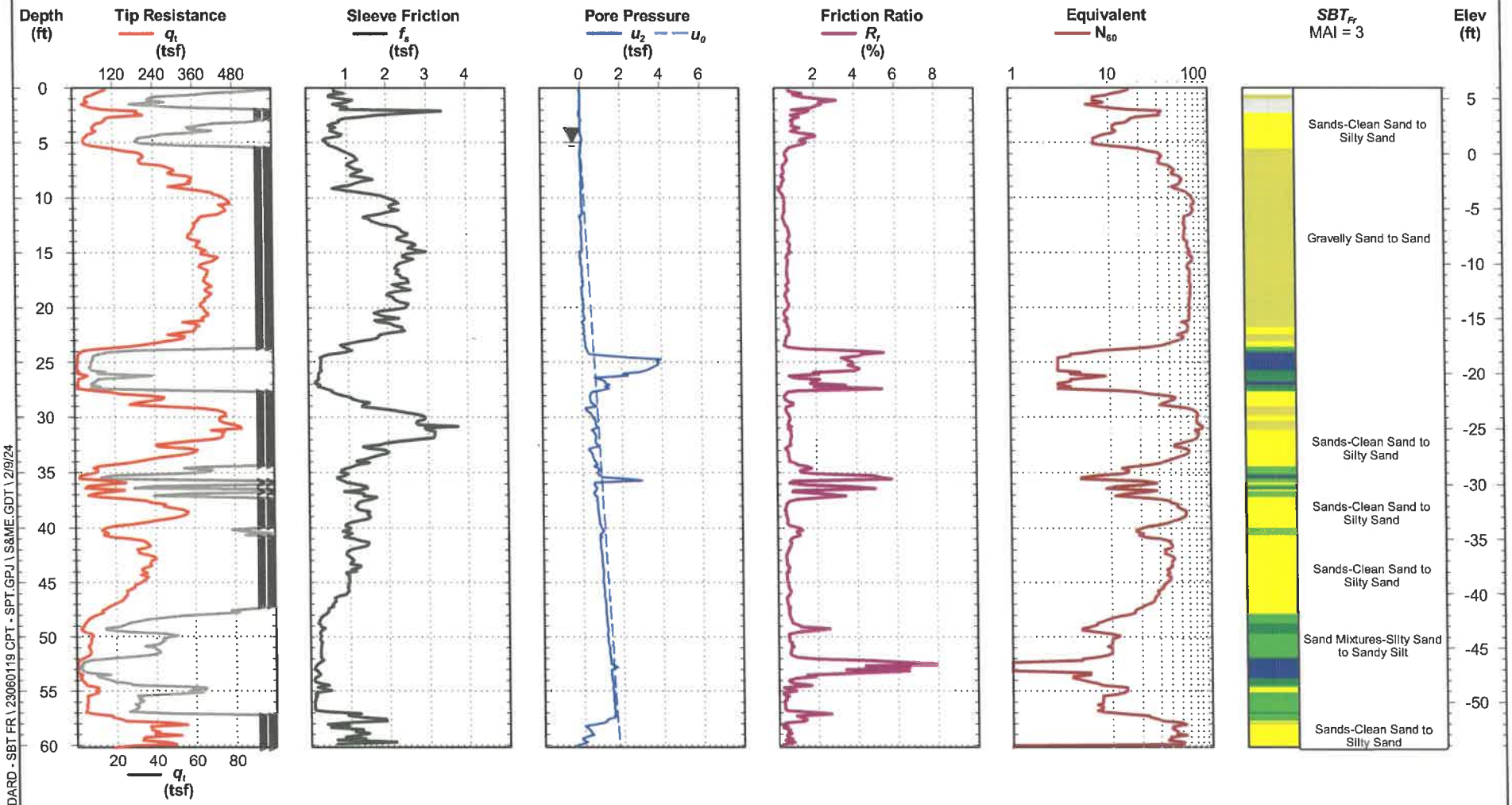
Cone Penetration Test

Electronic Filename: NC Aquarium at Fort Fisher S-1.cpt

Sounding ID: S-2

NC Aquarium Ft. Fisher Addition
Kure Beach, North Carolina
S&ME Project No: 23060119

Date:	Feb. 8, 2024	**Total Depth:**	60.2 ft
Estimated Water Depth:	5 ft	**Termination Criteria:**	Target Depth
Rig/Operator:	Jared Duffy	**Cone Size:**	1.75



Cone Penetration Test

Electronic Filename: NC Aquarium at Fort Fisher S-2.cpt

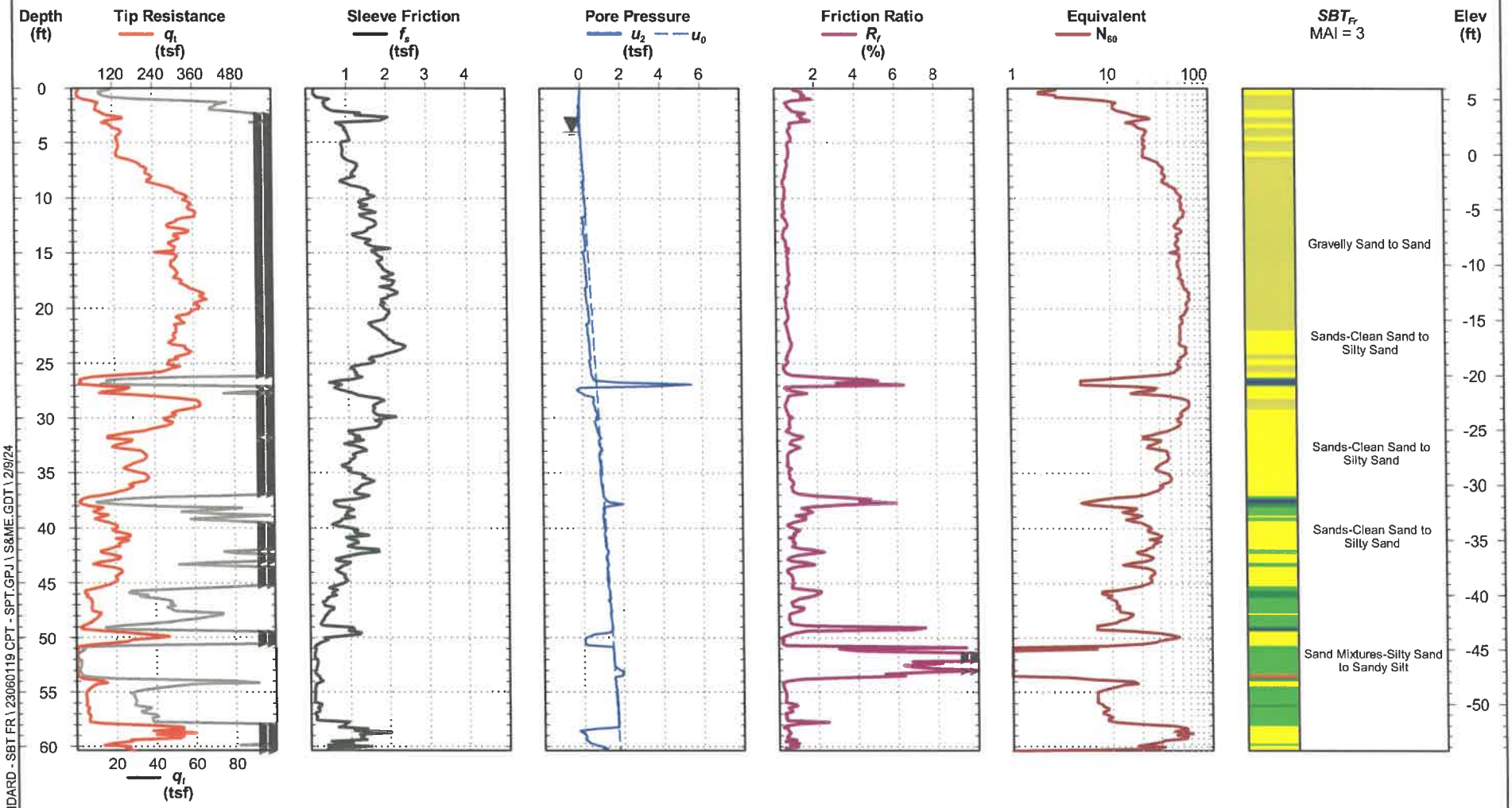
CPT REPORT - STANDARD - SBT FR \ 23060119 CPT - SPT.GPJ \ S&ME.GDT \ 2/9/24

Sounding ID: S-3

NC Aquarium Ft. Fisher Addition
Kure Beach, North Carolina
S&ME Project No: 23060119

Date: Feb. 8, 2024
Estimated Water Depth: 4 ft
Rig/Operator: Jared Duffy

Total Depth: 60.4 ft
Termination Criteria: Target Depth
Cone Size: 1.75



CPT REPORT - STANDARD - SBT FR \ 23060119 CPT - SPT.GPJ \ S&ME.GDT \ 2/9/24

Cone Penetration Test

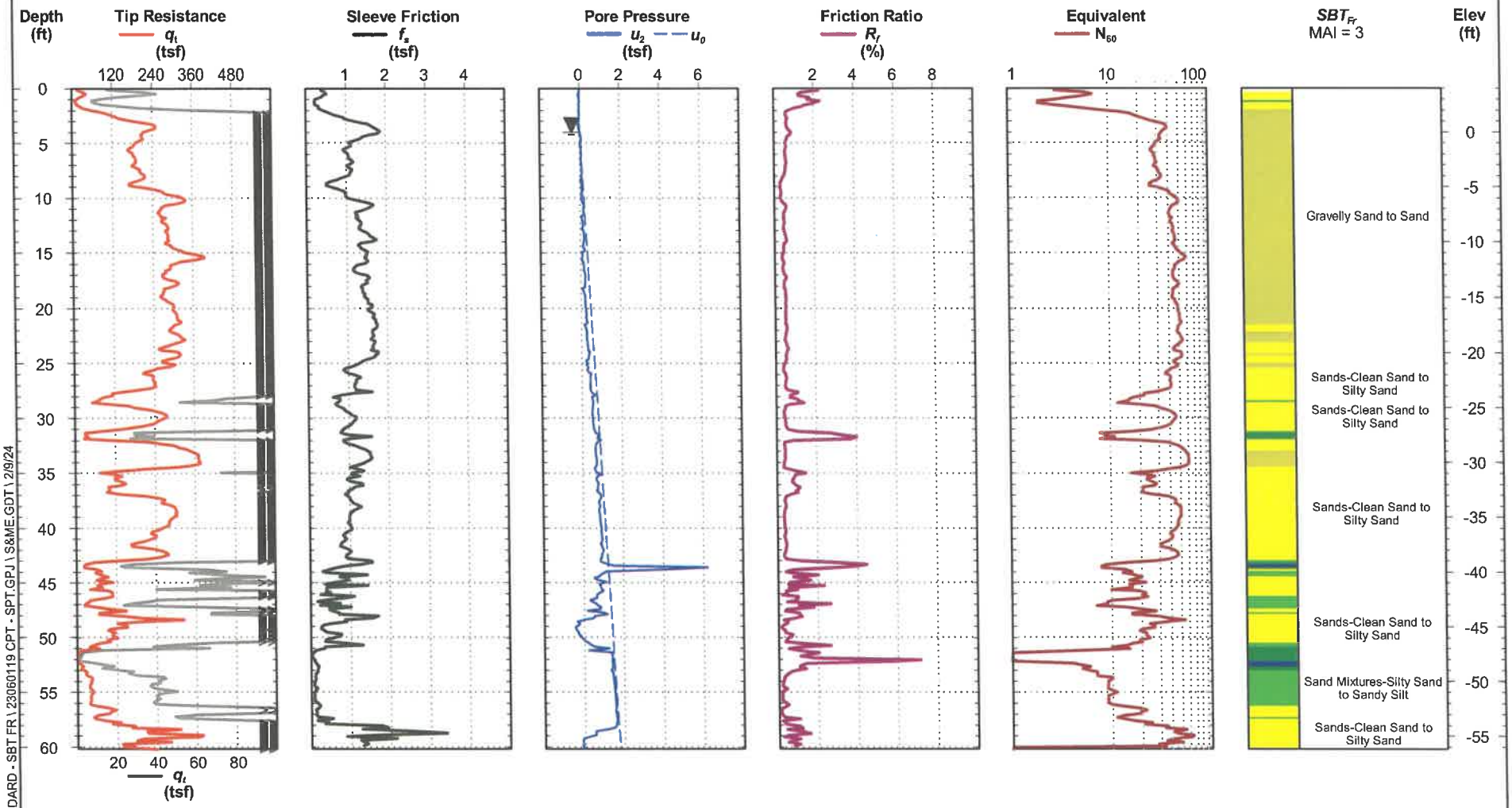
Electronic Filename: NC Aquarium at Fort Fisher S-3.cpt

Sounding ID: S-4

NC Aquarium Ft. Fisher Addition
Kure Beach, North Carolina
S&ME Project No: 23060119

Date: Feb. 8, 2024
Estimated Water Depth: 4 ft
Rig/Operator: Jared Duffy

Total Depth: 60.2 ft
Termination Criteria: Target Depth
Cone Size: 1.75



CPT REPORT - STANDARD - SBT FR \ 23060119 CPT - SPT.GPJ \ S&ME.GDT \ 2/9/24

Cone Penetration Test

Electronic Filename: NC Aquarium at Fort Fisher S-4.cpt

LEGEND TO SOIL CLASSIFICATION AND SYMBOLS

SOIL TYPES

(Shown in Graphic Log)


Fill


Asphalt


Concrete


Topsoil


Gravel


Sand


Silt


Clay


Organic


Silty Sand


Clayey Sand


Sandy Silt


Clayey Silt


Sandy Clay


Silty Clay


Partially Weathered Rock


Cored Rock

WATER LEVELS

(Shown in Water Level Column)

▽ = Water Level At Termination of Boring
▼ = Water Level Taken After 24 Hours
◄ = Loss of Drilling Water
HC = Hole Cave

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Soft	0 to 2
Soft	3 to 4
Firm	5 to 8
Stiff	9 to 15
Very Stiff	16 to 30
Hard	31 to 50
Very Hard	Over 50

RELATIVE DENSITY OF COHESIONLESS SOILS

RELATIVE DENSITY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Loose	0 to 4
Loose	5 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	Over 50

SAMPLER TYPES

(Shown in Samples Column)


Shelby Tube


Split Spoon


Rock Core


No Recovery

TERMS

Standard Penetration Resistance - The Number of Blows of 140 lb. Hammer Falling 30 in. Required to Drive 1.4 in. I.D. Split Spoon Sampler 1 Foot. As Specified in ASTM D-1586.

REC - Total Length of Rock Recovered in the Core Barrel Divided by the Total Length of the Core Run Times 100%.

RQD - Total Length of Sound Rock Segments Recovered that are Longer Than or Equal to 4" (mechanical breaks excluded) Divided by the Total Length of the Core Run Times 100%.



NC Aquarium Ft. Fisher Addition
Kure Beach, North Carolina
S&ME Project No. 23060119

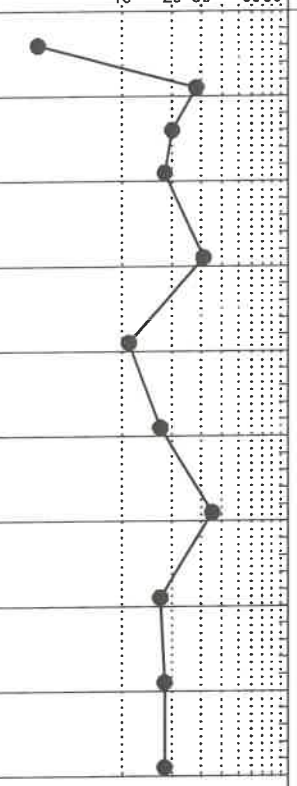
BORING LOG B-1

DATE DRILLED: **2/9/24**	ELEVATION: **4.0 ft**
DRILL RIG: **CME 45**	BORING DEPTH: **45.0 ft**
DRILLER: **Mid-Atlantic/TS**	WATER LEVEL: **4.3' ATD, 0.1' 24 hr**
HAMMER TYPE: **Auto**	LOGGED BY: **J. Faucette**
SAMPLING METHOD: **Split spoon**	
DRILLING METHOD: **Mud Rotary**	

NOTES:

DEPTH (feet)	MATERIAL DESCRIPTION	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	N VALUE
0	**POORLY GRADED SAND (SP)** - Very loose, gray, mostly fine to medium sands, trace low plasticity to non-plastic fines, wet.		1		1	1	2	3
		-1.0	2		6	9	19	28
5	- - - Medium dense.		3		6	11	9	20
		-6.0	4		6	8	10	18
10								
		-11.0	5		9	15	16	31
15	- - - Dense, with some shells.							
		-16.0	6		11	7	4	11
20	**POORLY GRADED SAND WITH SILT (SP-SM)** - Medium dense, gray, mostly fine to medium sands, few low plasticity to non-plastic fines, wet.							
		-21.0	7		4	7	10	17
25								
	- - - Dense.	-26.0	8		4	12	23	35
30								
	- - - Medium dense.	-31.0	9		6	8	9	17
35								
		-36.0	10		3	8	10	18
40								
		-41.0	11		4	10	8	18
45	**POORLY GRADED SAND WITH SILT (SP-SM)** - Medium dense, gray, mostly fine to medium sands, some cemented fragments, few low plasticity to non-plastic fines, wet.							
	Boring terminated at 45 ft Target Depth							

STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS



S&ME BORING LOG \ 23060119 CPT - SPT.GPJ \ LIBRARY 2011 06 28.GDT \ 5/13/24

NOTES:

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2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

NC Aquarium Ft. Fisher Addition
Kure Beach, North Carolina

S&ME Project No. 23060119

BORING LOG B-2

DATE DRILLED: **2/8/24**	ELEVATION: **5.0 ft**
DRILL RIG: **CME 45**	BORING DEPTH: **60.0 ft**
DRILLER: **Mid-Atlantic/TS**	WATER LEVEL: **3.4' ATD**
HAMMER TYPE: **Auto**	LOGGED BY: **J. Faucette**
SAMPLING METHOD: **Split spoon**	
DRILLING METHOD: **Mud Rotary**	

NOTES:

DEPTH (feet)	MATERIAL DESCRIPTION	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	N VALUE
0	**POORLY GRADED SAND (SP)** - Loose, gray, mostly fine to medium sands, trace low plasticity to non-plastic fines, wet.	5.0	1	SS	2	4	4	8
5	- - - Medium dense, with some shell fragments.	0.0	2	SS	5	7	10	17
10		-5.0	3	SS	8	11	14	25
15		-10.0	4	SS	7	11	12	23
20	**POORLY GRADED SAND WITH SILT (SP-SM)** - Medium dense, gray, mostly fine to medium sands, few low plasticity to non-plastic fines, wet.	-15.0	5	SS	3	11	10	21
25	- - - Loose.	-20.0	6	SS	4	11	8	19
30	**POORLY GRADED SAND (SP)** - Medium dense, gray, mostly fine to medium sands, trace low plasticity to non-plastic fines, wet.	-25.0	7	SS	2	4	5	9
35		-30.0	8	SS	5	7	10	17
40		-35.0	9	SS	10	12	12	24
45	**POORLY GRADED SAND WITH SILT (SP-SM)** - Medium dense, gray, mostly fine to medium sands, with cemented fragments, few low plasticity to non-plastic fines, wet.	-40.0	10	SS	7	8	5	13
50		-45.0	11	SS	3	5	7	12
55		-50.0	12	SS	4	8	8	16
60	**POORLY GRADED SAND (SP)** - Very dense, gray, mostly fine to medium sands, with cemented fragments, trace low plasticity to non-plastic fines, wet.	-55.0	13	SS	7	4	7	11
	Boring terminated at 60 ft Target Depth		14	SS	22	24	31	55

STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS — 10 20 30 60 80

S&ME BORING LOG \ 23060119 CPT - SPT.GPJ \ LIBRARY 2011_06_28.GDT \ 5/13/24

NOTES:

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3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

NC Aquarium Ft. Fisher Addition
Kure Beach, North Carolina
S&ME Project No. 23060119

BORING LOG B-3

DATE DRILLED: **2/9/24**	ELEVATION: **4.0 ft**
DRILL RIG: **CME 45**	BORING DEPTH: **45.0 ft**
DRILLER: **Mid-Atlantic/TS**	WATER LEVEL: **2' ATD, 0.4' 24 hr**
HAMMER TYPE: **Auto**	LOGGED BY: **J. Faucette**
SAMPLING METHOD: **Split spoon**	
DRILLING METHOD: **Mud Rotary**	

NOTES:

DEPTH (feet)	MATERIAL DESCRIPTION	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / ROD	N VALUE
5	**POORLY GRADED SAND (SP)** - Loose, gray, mostly fine to medium sands, trace low plasticity to non-plastic fines, wet.		1		2	3	4	7
	- - - Medium dense.	-1.0	2		4	8	10	18
10			3		5	8	11	19
		-6.0	4		8	13	16	29
15		-11.0	5		8	12	16	28
20	**SANDY CLAY (CL)** - Firm, gray, mostly low to medium plasticity fines, some fine sands, wet.	-16.0	6		5	3	3	6
25	**POORLY GRADED SAND (SP)** - Very dense, gray, mostly fine to medium sands, trace low plasticity to non-plastic fines, wet.	-21.0	7		16	23	29	52
	- - - Medium dense.	-26.0	8		6	14	8	22
30								
35	- - - Loose.	-31.0	9		5	3	4	7
40	- - - Medium dense.	-36.0	10		9	12	15	27
45	**POORLY GRADED SAND WITH SILT (SP-SM)** - Very loose, gray, mostly fine to medium sands, with cemented fragments, few low plasticity to non-plastic fines, wet.	-41.0	11		1	1	2	3
	Boring terminated at 45 ft Target Depth							

STANDARD PENETRATION TEST DATA (blows/ft) / REMARKS — 10 20 30 60 80

S&ME BORING LOG \ 23060119 CPT - SPT.GPJ \ LIBRARY 2011 06 28.GDT \ 5/13/24

NOTES:

1. *THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.*
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3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

NC Aquarium Ft. Fisher Addition
Kure Beach, North Carolina
S&ME Project No. 23060119

BORING LOG B-4

DATE DRILLED: **2/9/24**	ELEVATION: **8.0 ft**
DRILL RIG: **CME 45**	BORING DEPTH: **60.0 ft**
DRILLER: **Mid-Atlantic/TS**	WATER LEVEL: **4.8' ATD, 5.6' 24 hr**
HAMMER TYPE: **Auto**	LOGGED BY: **J. Faucette**
SAMPLING METHOD: **Split spoon**	
DRILLING METHOD: **Mud Rotary**	

NOTES:

DEPTH (feet)	MATERIAL DESCRIPTION	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	STANDARD PENETRATION TEST DATA (blows/ft) /REMARKS	N VALUE
0	**POORLY GRADED SAND (SP)** - Loose, gray, mostly fine to medium sands, trace low plasticity to non-plastic fines, wet.	8.0							
5	- - - Medium dense.	3.0	1		1	3	3		6
			2		2	3	6		9
10	- - - With some shell fragments.		3		3	6	12		18
		-2.0	4		8	14	16		30
15		-7.0	5		8	16	14		30
20		-12.0	6		10	12	12		24
25	**SANDY CLAY (CL)** - Soft, gray, mostly low to medium plasticity fines, some fine sand, wet.	-17.0	7		2	2	2		4
30	- - - Firm.	-22.0	8		4	3	2		5
35	**POORLY GRADED SAND (SP)** - Medium dense, gray, mostly fine to medium sands, trace low plasticity to non-plastic fines, wet.	-27.0	9		4	8	17		25
40		-32.0	10		8	10	14		24
45		-37.0	11		10	15	12		27
50	**POORLY GRADED SAND WITH SILT (SP-SM)** - Loose, gray, mostly fine to medium sands, with cemented fragments, few low plasticity to non-plastic fines, wet.	-42.0	12		3	4	5		9
55		-47.0	13		5	3	3		6
60	- - - Medium dense.	-52.0	14		10	18	12		30
	Boring terminated at 60 ft Target Depth								

S&ME BORING LOG \ 23060119 CPT - SPT.GPJ \ LIBRARY 2011 06 28.GDT \ 5/13/24

NOTES:

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2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

PROJECT:	NC Aquarium Fort Fisher Addition Kure Beach, North Carolina 23060119	**HAND AUGER BORING LOG: S-1**
DATE STARTED: 2/7/24	DATE FINISHED: 2/7/24	NOTES: Auger refusal due to borehole collapse.
SAMPLING METHOD: Hand Auger	PERFORMED BY: S&ME/N. Buffum	
WATER LEVEL: 1.5' ATD		

Depth (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION (feet)	WATER LEVEL
		FILL: POORLY GRADED SAND (SP) - Tan, mostly fine sand to medium sand, some gravel, trace fines, wet.		
1		**POORLY GRADED SAND (SP)** - Tan, mostly fine sand to medium sand, trace fines, wet.		▽
2				
3				
		Boring terminated at 3.5 ft due to auger refusal Auger Refusal		

PROJECT:	NC Aquarium Fort Fisher Addition Kure Beach, North Carolina 23060119	**HAND AUGER BORING LOG: S-2**
DATE STARTED: 2/7/24	DATE FINISHED: 2/7/24	NOTES:
SAMPLING METHOD: Hand Auger	PERFORMED BY: S&ME/N. Buffum	
WATER LEVEL: Not encountered.		

Depth (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION (feet)	WATER LEVEL
1		**FILL: POORLY GRADED SAND (SP)** - Tan, mostly fine sand to medium sand, some gravel, trace fines, wet.		
2				
3		**POORLY GRADED SAND (SP)** - Tan, mostly fine sand to medium sand, trace fines, moist/wet.		
4		Boring terminated at 4 ft Target Depth		

PROJECT:	NC Aquarium Fort Fisher Addition Kure Beach, North Carolina 23060119	**HAND AUGER BORING LOG: S-3**
DATE STARTED: 2/7/24	DATE FINISHED: 2/7/24	NOTES:
SAMPLING METHOD: Hand Auger	PERFORMED BY: S&ME/N. Buffum	
WATER LEVEL: Not encountered.		

Depth (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION (feet)	WATER LEVEL
1		**FILL: POORLY GRADED SAND (SP)** - Tan, mostly fine sand to medium sand, some gravel, trace fines, wet.		
2				
3		**POORLY GRADED SAND (SP)** - Tan, mostly fine sand to medium sand, trace fines, moist/wet.		
4		Boring terminated at 4 ft Target Depth		

PROJECT:	NC Aquarium Fort Fisher Addition Kure Beach, North Carolina 23060119	**HAND AUGER BORING LOG: S-4A**
DATE STARTED: 2/7/24	DATE FINISHED: 2/7/24	NOTES:
SAMPLING METHOD: Hand Auger	PERFORMED BY: S&ME/N. Buffum	
WATER LEVEL: 2.6' ATD		

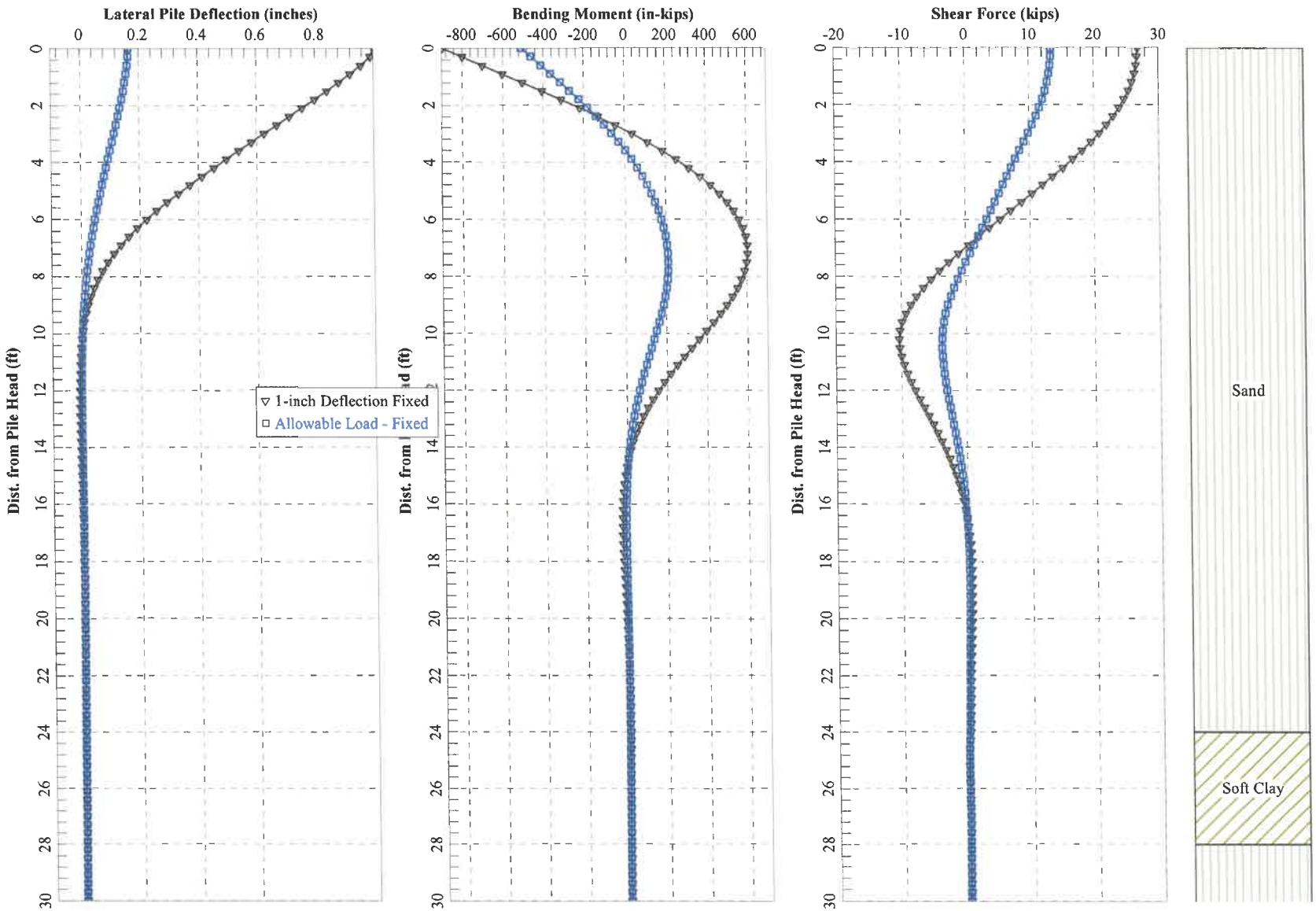
Depth (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION (feet)	WATER LEVEL
1		**FILL: POORLY GRADED SAND (SP)** - Tan, mostly fine sand to medium sand, some gravel, trace fines, wet.		
2		**POORLY GRADED SAND (SP)** - Tan and brown, mostly fine sand to medium sand, trace fines, moist/wet.		▽
3				
4		Boring terminated at 4 ft Target Depth		

PROJECT:	NC Aquarium Fort Fisher Addition Kure Beach, North Carolina 23060119	**HAND AUGER BORING LOG: S-4B**
DATE STARTED: 2/7/24	DATE FINISHED: 2/7/24	NOTES: Auger refusal due to borehole collapse.
SAMPLING METHOD: Hand Auger	PERFORMED BY: S&ME/N. Buffum	
WATER LEVEL: 2.3' ATD		

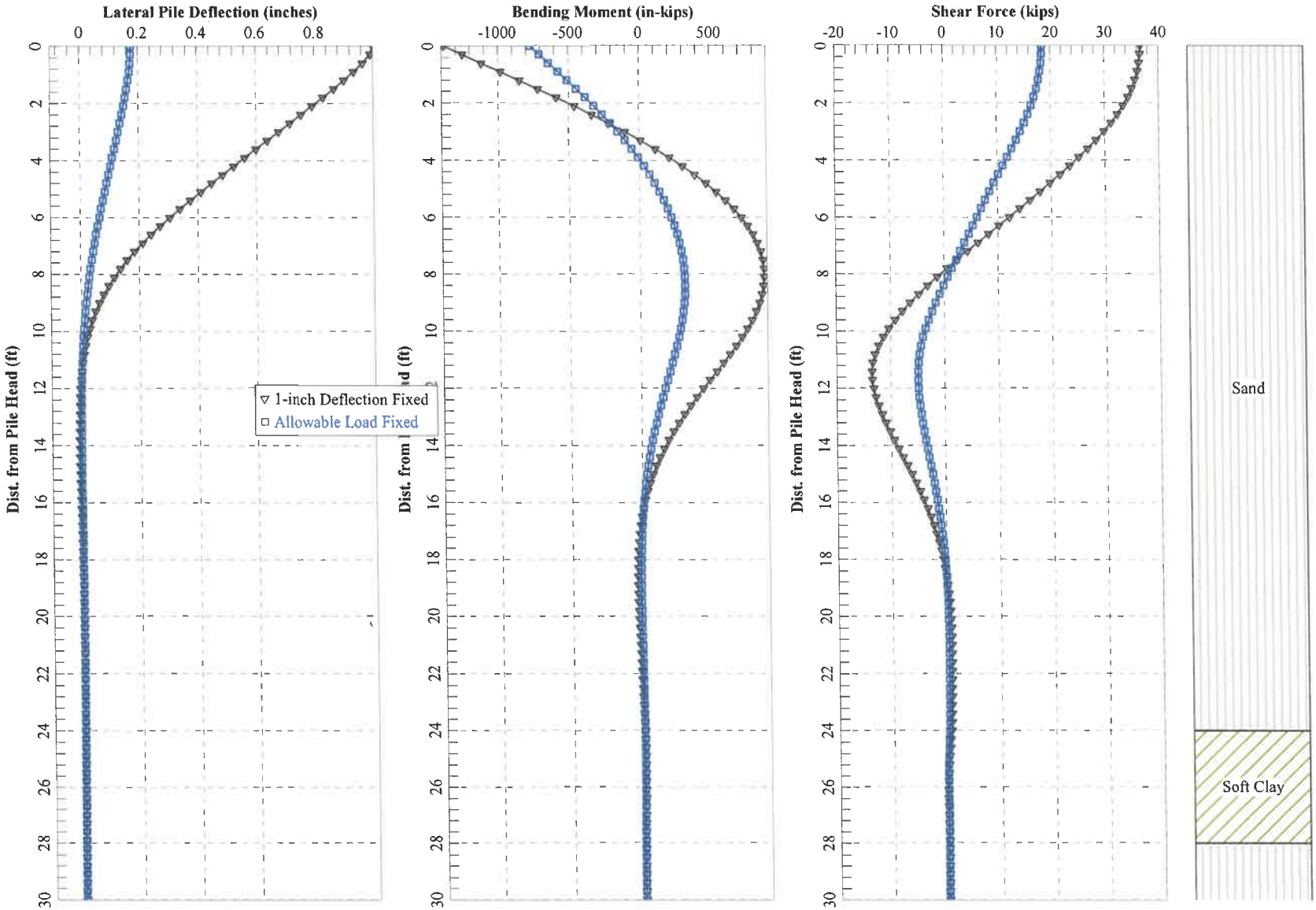
Depth (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION (feet)	WATER LEVEL
1		**POORLY GRADED SAND (SP)** - Brown and tan, mostly fine sand to medium sand, trace fines, moist/wet.		
2				▽
3		Boring terminated at 3 ft due to auger refusal Auger Refusal		

Appendix III – LPILE Deflection Model Results

LPILE Deflection Model Results: 14-inch ACIP Pile, 30-foot Length, Fixed Head



LPILE Deflection Model Results: 16-inch ACIP Pile, 30-foot Length, Fixed Head



SECTION 011000 – SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Phased construction and Contract Time.
4. Work under separate contracts.
5. Access to site.
6. Coordination with occupants.
7. Work restrictions.
8. Specification and drawing conventions.
9. Miscellaneous provisions.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

2. Refer to Section “Instructions to Bidders and General Conditions of the Contract; NC State Form OC-15, Twenty Fourth Edition, January 2013”.

1.2 PROJECT INFORMATION

A. Project Identification: NC Aquarium at Fort Fisher – Renovations + Additions

B. Project Locations: Ft Fisher Aquarium
900 Loggerhead Road
Kure Beach, NC 28449

C. Owner: State of North Carolina through Department of Natural & Cultural Resources

D. Owner's Representative: James Mancari, Project Manager.

E. Architect: Szostak Design Inc. Phil Nelson, Principal-in-Charge.

1.3 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and consists of the following items:

1. Addition 1 (Shark Tank Building): Construct complete 3-Story addition to house the new shark tank exhibit on deep micro pile foundations and grade beams with a superstructure of cast in place concrete columns and beams. Floors and roof slabs will be cast in place concrete. Exterior

walls will have continuous insulation with an EIFS finish. Roofing will be a fully adhered TPO membrane.

Renovation to the existing aquarium building will include replacement of finishes and new exhibits including a large cast in place concrete “touch tank”. Plumbing fixtures, mechanical equipment and electrical gear will be replaced. Also included are new powerhouse and physical plant structures to house electrical and mechanical equipment. .

B. Information Conflicts in the Contract Documents.

1. The Construction Manager at Risk (CMR) and his Agents will notify the Designer when conflicts are discovered in the Contract Documents.
2. Where conflicts occur in the Contract Documents and the Designer has not provided a resolution to them in written form the Construction Manager at Risk (herein after referred to as CMR) will presume the higher quality of the methods, means or products involved is the intent of the Designer.

C. Payment to the Designer for additional Inspections and Submittal reviews.

1. If the CMR notifies the Designer that he is ready for an Inspection that is required by the contract Documents and it is determined, upon viewing the condition of the Work that this is not the case then the CMR will be charged the cost of the Designer’s time and expenses to come to the jobsite at the Architect’s Standard Hourly Rates, and the IRS Standard Mileage Rate.
2. Submittals that are not satisfactory after one Re-submittal may be subject to a charge for the time required by the designer to review it again. That charge will be for the actual cost of the work, per the Designers’ standard hourly rates.

1.4 WORK UNDER SEPARATE CONTRACTS

A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract or other contracts. Coordinate the Work of this Contract with work performed under separate contracts.

1.5 PHASING OF THE WORK AND OWNER OCCUPANCY OF ADJACENT STRUCTURE

A. The Owner will continuously occupy the aquarium, along with the animals in all of the remaining exhibits. The facility will be closed to the public, for periods that will be negotiated with the CMR, to allow for construction work. The intent is to keep the Aquarium open to visitors during construction when feasible.

B. There will be an early phase of work to upgrade the existing electrical power, power distribution facilities, reconfigure power feeds to the administration areas and upgrade the fire alarm system in advance of the main addition/renovation project.

1.6 SPECIFICATION AND DRAWING CONVENTIONS

A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.

B. Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:

1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
2. Abbreviations: Materials and products are identified by abbreviations published as part of the U.S. National CAD Standard and scheduled on Drawings.
3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

1 END OF SECTION 011000

SECTION 012100 - ALLOWANCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements governing allowances.

B. Types of allowances include the following:

1. Lump-sum allowances.
2. Unit-cost allowances.
3. Quantity allowances.
4. Contingency allowances.

C. Related Requirements:

1. Section 012200 "Unit Prices" for procedures for using unit prices.

1.2 SELECTION AND PURCHASE

A. At the earliest practical date after award of the Contract, advise Architect of the date when final selection and purchase of each product or system described by an allowance must be completed to avoid delaying the Work.

B. At Architect's request, obtain proposals for each allowance for use in making final selections. Include recommendations that are relevant to performing the Work.

C. Purchase products and systems selected by Architect from the designated supplier.

1.3 ACTION SUBMITTALS

A. Submit proposals for purchase of products or systems included in allowances, in the form specified for Change Orders.

1.4 INFORMATIONAL SUBMITTALS

A. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.

B. Submit time sheets and other documentation to show labor time and cost for installation of allowance items that include installation as part of the allowance.

C. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.

1.5 COORDINATION

A. Coordinate allowance items with other portions of the Work. Furnish templates as required to coordinate installation.

1.6 LUMP-SUM, UNIT-COST, AND QUANTITY ALLOWANCES

A. Allowance shall include cost to Contractor of specific products and materials ordered by Owner or selected by Architect under allowance and shall include taxes, freight**,** and delivery to Project site.

B. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials under allowance shall be included as part of the Contract Sum and not part of the allowance.

C. Unused Materials: Return unused materials purchased under an allowance to manufacturer or supplier for credit to Owner, after installation has been completed and accepted.

1. If requested by Architect, retain and prepare unused material for storage by Owner. Deliver unused material to Owner's storage space as directed.

1.7 CONTINGENCY ALLOWANCES

A. Use the contingency allowance only as directed by Architect for Owner's purposes and only by Change Orders that indicate amounts to be charged to the allowance.

B. Contractor's **overhead, profit, and** related costs for products and equipment ordered by Owner under the contingency allowance are included in the allowance and are not part of the Contract Sum. These costs include delivery, installation**, taxes**, insurance, equipment rental, and similar costs.

C. Change Orders authorizing use of funds from the contingency allowance will include Contractor's related costs and reasonable overhead and profit margins.

D. At Project closeout, credit unused amounts remaining in the contingency allowance to Owner by Change Order.

1.8 ADJUSTMENT OF ALLOWANCES

A. Allowance Adjustment: To adjust allowance amounts, prepare a Change Proposal based on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place where applicable. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.

1. Include installation costs in purchase amount only where indicated as part of the allowance.

2. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other margins claimed.

3. Submit substantiation of a change in scope of work, if any, claimed in Change Orders related to unit-cost allowances.

4. Owner reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.

B. Submit claims for increased costs because of a change in scope or nature of the allowance described in the Contract Documents, whether for the purchase order amount or Contractor's handling, labor, installation, overhead, and profit.

1. Do not include Contractor's or subcontractor's indirect expense in the Change Proposal cost amount unless it is clearly shown that the nature or extent of work has changed from what could have been foreseen from information in the Contract Documents.

2. No change to Contractor's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

C. The Architect will create a Change Directive on a monthly basis, based on the sum of the Allowances and the allowance sum used to date, for acceptance by the Contractor and the Owner. The amount of this Change Directive may be drawn for the following Application for Payment.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

3.2 PREPARATION

A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

3.3 SCHEDULE OF ALLOWANCES

A. Allowance No. 1: Quantity Allowance: **Unsuitable Soil removal and disposal on-site: 250 cy**.

B. Allowance No. 2: **Quantity Allowance: Unsuitable Soil or existing loose fill soil re-placement with on-site suitable soil in place: 250cy.**

C. Allowance No. 3: **Quantity Allowance: Unsuitable Soil removal and disposal off-site: 250 cy.**

D. Allowance No. 4: **Quantity Allowance: Replacement of removed unsuitable soils with on-site suitable soil in-place: 250 cy.**

E. Allowance No. 5: **Quantity Allowance: Replacement of removed unsuitable soils with Select Granular Material in-place: 250 cy.**

F. Allowance No. 6: **Quantity Allowance: Replacement of unsuitable soils with Aggregate Base Course NCDOT (ABC STONE) in-place: 100cy.**

G. Allowance No. 7: **Quantity Allowance: Replacement of unsuitable or wet soils with No.57 washed stone in-place: 100cy.**

H. Allowance No. 8: **Quantity Allowance: Woven Geo-Textile Fabric in place: 200sy**

I. Allowance No. 9: **Quantity Allowance: Biaxial Geo-Grid in place: 200sy**

END OF SECTION 012100,0

SECTION 012200 - UNIT PRICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for unit prices.

B. Related Requirements:

1. Section 012600 "Contract Modification Procedures" for procedures for submitting and handling Change Orders.

1.2 DEFINITIONS

A. Unit price is an amount incorporated in the Agreement, applicable during the duration of the Work as a price per unit of measurement for materials, equipment, or services, or a portion of the Work, added to or deducted from the Contract Sum by appropriate modification, if the scope of Work or estimated quantities of Work required by the Contract Documents are increased or decreased.

1.3 PROCEDURES

A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.

B. Measurement and Payment: See individual Specification Sections for work that requires establishment of unit prices. Methods of measurement and payment for unit prices are specified in those Sections.

C. Owner reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.

D. List of Unit Prices: A schedule of unit prices is included in Part 3. Specification Sections referenced in the schedule contain requirements for materials described under each unit price.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF UNIT PRICES

A. Unit Price No. 1: **Unsuitable Soil removal and disposal on-site.**

1. Purpose: To adjust the contract sum in case a quantity different from that indicated in the allowance is required.
2. Unit of measurement: cubic yard measured before removal.
3. Include the following in the unit price:

    a. Excavation, loading, transport, and legal disposal of all materials.
    b. All disposal fees.
    c. Overhead and profit.

4. Include all other related costs in the contract sum.
5. Method of measurement: Quantities will be verified by a soils and materials engineer employed by the Owner based on volume of excavation.
6. Quantity Allowance: Coordinate unit price with allowance adjustment requirements of Division 01 Section “Allowances.”

B. Unit Price No. 2: **Replacement of unsuitable soils or existing loose fill soil with on-site suitable soil in-place.**

1. Purpose: To adjust the contract sum in case a quantity different from that indicated in the allowance is required.
2. Unit of measurement: cubic yard of void to be filled.
3. Include the following in the unit price:

    a. Excavation, loading, transport, of suitable soil materials from on-site borrow area.
    b. Placement and compaction of soil into void remaining from removed rock or unsuitable soil.
    c. Overhead and profit.

4. Include all other related costs in the contract sum.
5. Do not include removal of unsuitable soil. Include costs related to removal of unsuitable soil in other Unit Prices.
6. Method of measurement: Quantities will be verified by a soils and materials engineer employed by the Owner based on volume of void to be filled.
7. Quantity Allowance: Coordinate unit price with allowance adjustment requirements of Division 01 Section “Allowances.”

C. Unit Price No. 3: **Unsuitable Soil or existing loose fill soil removal and disposal off-site.**

1. Purpose: To adjust the contract sum in case a quantity different from that indicated in the allowance is required.
2. Unit of measurement: cubic yard measured before removal.
3. Include the following in the unit price:

    a. Excavation from below subgrade elevations.
    b. Loading and on-site transport of all materials.
    c. Placement, compaction and moisture conditioning of materials in on-site fill area.
    d. Overhead and profit.

4. Include all other related costs in the contract sum.
5. Method of measurement: Quantities will be verified by a soils and materials engineer employed by the Owner based on measured volume of excavation.
6. Quantity Allowance: Coordinate unit price with allowance adjustment requirements of Division 01 Section “Allowances.”

D. Unit Price No. 4: **Replacement of removed unsuitable soils with on-site suitable soil in-place.**

1. Purpose: To adjust the contract sum in case a quantity different from that indicated in the allowance is required.
2. Unit of measurement: cubic yard of void to be filled.
3. Include the following in the unit price:

    a. Suitable soil materials from contractor’s off-site source.
    b. Excavation, loading, transport, placement and compaction of soil into void remaining from removed rock or unsuitable soil.
    c. Overhead and profit.

4. Include all other related costs in the contract sum.
5. Do not include removal of unsuitable soil. Include costs related to removal of unsuitable soil in other Unit Prices.
6. Method of measurement: Quantities will be verified by a soils and materials engineer employed by the Owner based on volume of void to be filled.
7. Quantity Allowance: Coordinate unit price with allowance adjustment requirements of Division 01 Section “Allowances.”

E. Unit Price No. 5: **Replacement of removed unsuitable soils with Select Granular Material in-place**.

1. Purpose: To adjust the contract sum in case a quantity different from that indicated in the allowance is required.
2. Unit of measurement: cubic yard of void to be filled.
3. Include the following in the unit price:

    a. Select Granular Material from contractor’s off-site source.
    b. Excavation, loading, transport, placement and compaction of soil into void remaining from removed rock or unsuitable soil.
    c. Overhead and profit.

4. Include all other related costs in the contract sum.
5. Do not include removal of unsuitable soil. Include costs related to removal of unsuitable soil in other Unit Prices.
6. Method of measurement: Quantities will be verified by a soils and materials engineer employed by the Owner based on volume of void to be filled.
7. Quantity Allowance: Coordinate unit price with allowance adjustment requirements of Division 01 Section “Allowances.”

F. Unit Price No. 6: **Replacement of unsuitable soils with Aggregate Base Course in-place.**

1. Purpose: To adjust the contract sum in case a quantity different from that indicated in the allowance is required.
2. Unit of measurement: cubic yard of void to be filled.
3. Include the following in the unit price:

    a. Certified ABC materials from contractor's off-site source.
    b. Excavation, loading, transport, placement and compaction of ABC into void remaining from removed rock or unsuitable soil.
    c. Overhead and profit.

4. Include all other related costs in the contract sum.
5. Do not include removal of unsuitable soil. Include costs related to removal of unsuitable soil in other Unit Prices.
6. Method of measurement: Quantities will be verified by a soils and materials engineer employed by the Owner based on volume of void to be filled.
7. Quantity Allowance: Coordinate unit price with allowance adjustment requirements of Division 01 Section "Allowances."

G. Unit Price No. 7**: Replacement of unsuitable soils with No.57 washed stone in-place.**

1. Purpose: To adjust the contract sum in case a quantity different from that indicated in the allowance is required.
2. Unit of measurement: cubic yard of void to be filled.
3. Include the following in the unit price:

    a. Certified #57 washed stone from contractor's off-site source.
    b. Excavation, loading, transport, placement and compaction of #57 washed stone into void remaining from removed rock or unsuitable soil.
    c. Overhead and profit.

4. Include all other related costs in the contract sum.
5. Do not include removal of unsuitable soil. Include costs related to removal of unsuitable soil in other Unit Prices.
6. Method of measurement: Quantities will be verified by a soils and materials engineer employed by the Owner based on volume of void to be filled.
7. Quantity Allowance: Coordinate unit price with allowance adjustment requirements of Division 01 Section "Allowances."

H. Unit Price No. 8: **Woven Geo-Textile Fabric in place.**

1. Purpose: To adjust the contract sum in case a quantity different from that indicated in the allowance is required.
2. Unit of measurement: square yard of surface to be covered.
3. Include the following in the unit price:

a. Materials and transport to site.
b. Unloading, handling, and placement.
c. Overhead and profit.

4. Include all other related costs in the contract sum.
5. Method of measurement: Quantities will be verified by a soils and materials engineer employed by the Owner based on the area of ground covered by the fabric. Excess and/or overlap shall not be included in the measurement.
6. Quantity Allowance: Coordinate unit price with allowance adjustment requirements of Division 01 Section “Allowances.”

I. Unit Price No. 9: **Biaxial Geo-Grid in place.**

1. Purpose: To adjust the contract sum in case a quantity different from that indicated in the allowance is required.
2. Unit of measurement: square yard of surface to be covered.
3. Include the following in the unit price:

a. Materials and transport to site.
b. Unloading, handling, and placement.
c. Overhead and profit.

4. Include all other related costs in the contract sum.
5. Method of measurement: Quantities will be verified by a soils and materials engineer employed by the Owner based on the area of ground covered by the fabric. Excess and/or overlap shall not be included in the measurement.
6. Quantity Allowance: Coordinate unit price with allowance adjustment requirements of Division 01 Section “Allowances.”

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END OF SECTION 012200

SECTION 012300 – ALTERNATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for alternates.

1.2 DEFINITIONS

A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.

1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

1.3 PROCEDURES

A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.

1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.

B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated revisions to alternates.

C. Execute accepted alternates under the same conditions as other work of the Contract.

D. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES FOR **PHASE ONE SCOPE**

A. Alternate No. **1** – **Not Used**

B. Alternate No. **2** – **Entry Lobby & Restroom Renovations**: Renovate main Entry Lobby area with expanded restroom space.

1. Base Bid: No changes to Entry Lobby or adjacent restrooms.
2. Alternate: Demolish interior areas in Entry Lobby #R123 and adjacent rooms per 1/AD-1.21B, and renovate per 1/A-2.21D, 1/A-3.21D and associated MEP+FP sheets.

C. Alternate No. **3** – **Exotic Aquatics Modifications & Additions**: Provide changes and additional exhibits in the Exotic Aquatics #R130 area in the existing aquarium space.

1. Base Bid: No changes to Exotic Aquatics #R130.
2. Alternate: Reconfigure circulation through Exotic Aquatics exhibits per A-2.21A and install exhibits per sheets X-209, X-210, X-211, X-212 along with associated life support systems and lighting.

D. Alternate No. **4** – **Level 2 Staff Bathroom Renovation**: Renovate existing staff bathrooms/showers in back of house area on level 2.

1. Base Bid: No changes to staff bathroom & shower rooms in this area.
2. Alternate: Demolish existing interior spaces per AD-1.22A and renovate per A-2.22A, A-3.22-A and associated MEP+FP sheets.

E. Alternate No. **5A** – **Renovate Level 1 Restroom #s R113 & R114**: Renovate existing men's and women's gang toilets R113 & R114.

1. Base Bid: No changes to these restrooms.
2. Alternate: Remove existing fixtures and partitions in R113 & R114 per 2/AD-1.21B and renovate per 5/A-4.11 and associated plumbing sheets.

F. Alternate No. **5B** – **Renovate Level 2 Restroom #s R215 & R216**: Renovate existing men's and women's gang toilets R215 & R216.

1. Base Bid: No changes to these restrooms.
2. Alternate: Remove existing fixtures and partitions in R215 & R216 per 2/AD-1.22B and renovate per 6/A-4.11 and associated plumbing sheets

G. Alternate No. **6** – **Main Parking Lot & Bus Lot**: Reconfigure main parking lot and satellite lot.

1. Base Bid: No work in either area.
2. Alternate: Reconfigure main and satellite parking areas per Civil sheets C-0, C-1, C-2.0, C-2.1, C-3, C-4 & C-5 and Landscape Sheets L-1.20 & L-1.30, including associated stormwater structures.

H. Alternate No. **7** – **Lighting & Controls in Existing Exhibits/Areas**: Provide new light fixtures and control system in existing exhibit spaces.

1. Base Bid: No change to lighting or controls in current exhibit areas.
2. Alternate: Provide new lighting fixtures and control systems per LT series drawings.

I. Alternate No. **8** – **Outdoor Classroom Roof**: Provide roof structure above outdoor classroom.

1. Base Bid: No roof covering in outdoor classroom area.
2. Alternate: Provide roof structure, roof covering, finish materials, lighting, sprinklers, and associated items in outdoor classroom area.

J. Alternate No. **9** – **Emergency Power Supply System (EPSS)**: Provide emergency generators and new fuel tank.

1. Base Bid: Engine-Generator sets, exhaust system and silencers, generators remote annunciators, day tanks DT01 and DT02, ATS-LS, ATS-LSS, ATS-OP, 20,000 gallon above ground fuel tank and concrete base, fuel piping, fuel tank control panel, fuel as specified, gen sets paralleling controls, feeders from gen sets to Switchboard EPS, grounding, engine -generators controls as shown in Detail 5/E-5.6, emergency power off switches, all installed, tested, commissioned and maintained by Duke Energy One. Contractor must provide supporting branch power circuits to each gen set and intake and exhaust louvers and power circuits.

2. Alternate: Provide and install EPSS as described above and per the Divisions 23 and 26 drawings and specifications.

K. Alternate No. **10**– **Epoxy coated Concrete**: Provide epoxy coating on concrete floors in select areas.

1. Base Bid: Provide sealed concrete floors per the Finish Schedule on A-9.1.

2. Alternate: Provide epoxy coating to floor areas as called out on Finish Schedule A-9.1 in the “Comments” column.

Preferred Alternates

L. Preferred Alternate No**. PA-1**– Provide **Kessil W500 Aquascape Series** light fixtures for exhibits as specified in section 265100.

M. Preferred Alternate No**. PA-2**– Provide either **Kessil W2K Aquascape Series** or **Maxspect commercial LED Floodlight Series** light fixtures as specified in section 265100 for the Live Coral exhibit.
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END OF SECTION 012300

SECTION 012600 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for handling and processing Contract modifications.

1.2 CHANGES IN THE WORK - GENERAL

A. Architect will issue written instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time.

B. No changes in the work will be considered authorized unless the CMR receives written instructions from the Architect, in advance, approving such changes.

1.3 PROPOSAL REQUESTS

A. Owner-Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.

1. Work Change Proposal Requests issued by Architect are not instructions either to stop work in progress or to execute the proposed change.
2. Within time specified in Proposal Request or 14 days, when not otherwise specified, after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.

    a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
    b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
    c. Include costs of labor and supervision directly attributable to the change.
    d. Include an updated CMR's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
    e. Quotation Form: Use forms included in Project Manual.

B. CMR-Initiated Work Change Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Architect.

1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.

3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
4. Include costs of labor and supervision directly attributable to the change.
5. Include an updated CMR's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
6. Comply with requirements in Division 01 Section "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
7. Work Change Proposal Request Form: Use form included in Project Manual.

1.4 ADMINISTRATIVE CHANGE ORDERS

A. Unit-Price Adjustment: See Division 01 Section "Unit Prices" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect measured scope of unit-price work.

1.5 CONSTRUCTION CHANGE DIRECTIVE

A. Construction Change Directive: Architect may issue a Construction Change Directive on Information Transmission Status part of the Construction Observation Report. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.

1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.

B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.

1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract, if an alternative lump sum has not previously been agreed upon.

PART 2 - PRODUCTS (Not Used)

1 PART 3 - EXECUTION

COST BREAKDOWN SUMMARY SHEET

Project:

Architect's Project Designation: Brief Description:

1 .	Products (itemized breakdown attached):		1
2 .	Rent of Equipment (listed separately):*	$ -	2
	TOTAL of 1 + 2	$ -	**A**
3 .	Labor (itemized breakdown attached):	$ -	3
4 .	Insurance (workman's compensation, social security, or as otherwise required or specified): %	$ -	4
	TOTAL (A) + 3 + 4	$ -	**B**
5 .	Overhead and Profit {15% of Total (B)}:**	$ -	5
	TOTAL of (B) + 5	$ -	**C**
6 .	Sales Taxes on Total (A):	$ -	6
	TOTAL of (C) + 6:	$ -	**D**
7 .	Subcontract work (if applicable in a similar breakdown through total (D). (Profit and Overhead Allowance 15%):	$ -	7
8 .	CMR's overhead and profit on 7 sub-bids (5%)***	$ -	8
	TOTAL of 7 + 8	$ -	**E**
	TOTAL of (D) + (E)	$ -	**F**
9 .	Performance-Payment Bond on total (F): %		
TOTAL QUOTATION (F) + 9		$ -	

Extension of time requested:_____ calendar days.

* Include current schedules with each request if equipment is involved.
** In case of deductible changes, this figure to be ten percent (10%).
*** In case of deductible changes, this figure to be zero percent (0%).

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2 END OF SECTION 012600

SECTION 012900 - PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.

B. Related Requirements:

1. Division 01 Section "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
2. Division 01 Section "Construction Progress Documentation" for administrative requirements governing the preparation and submittal of the CMR's construction schedule.

1.2 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of the schedule of values with preparation of CMR's construction schedule.

1. Coordinate line items in the schedule of values with other required administrative forms and schedules, including the following:

    a. Application for Payment forms with continuation sheets.
    b. Submittal schedule.
    c. Items required to be indicated as separate activities in CMR's construction schedule.

2. Submit the schedule of values to Architect at earliest possible date but no later than seven days before the date scheduled for submittal of initial Applications for Payment.
3. Sub-schedules for Phased Work: Where the Work is separated into phases requiring separately phased payments, provide sub-schedules showing values coordinated with each phase of payment.

B. Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section.

1. Identification: Include the following Project identification on the schedule of values:

    a. Project name and location.
    b. Name of Architect.
    c. Architect's project number.
    d. CMR's name and address.
    e. Date of submittal.

2. Arrange schedule of values consistent with format of AIA Document G703.

3. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with Project Manual table of contents.
4. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
5. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
6. Provide separate line items in the schedule of values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
7. Allowances: Provide a separate line item in the schedule of values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.
8. Each item in the schedule of values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.

    a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the schedule of values or distributed as general overhead expense, at CMR's option.

1.3 APPLICATIONS FOR PAYMENT

A. Each Application for Payment shall be consistent with previous applications and payments as certified by Architect and paid for by Owner.

1. Initial Application for Payment, Application for Payment at time of Beneficial Occupancy, and final Application for Payment involve additional requirements.

B. Payment Application Times: Submit Application for Payment to Architect by the 20th of the month. The period covered by each Application for Payment is one month, ending on the last day of the month. Modifications to this time period will be subject to the Owner's Approval.

C. Application for Payment Forms: Use AIA Document G702 and AIA Document G703 as form for Applications for Payment.

1. Provide Sale Tax Summary for the period of activity covered by the Pay Application.

D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.

1. Entries shall match data on the schedule of values and CMR's construction schedule. Use updated schedules if revisions were made.
2. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

E. Transmittal: Submit four signed and notarized original copies of each Application for Payment to Architect by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.

1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.

F. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from entities lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.

1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
2. When an application shows completion of an item, submit conditional final or full waivers.
3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
4. Waiver Forms: Submit executed waivers of lien on forms acceptable to Owner.

G. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:

1. List of subcontractors.
2. Schedule of values.
3. CMR's construction schedule (preliminary, if not final).
4. Schedule of unit prices.
5. Submittal schedule (preliminary if not final).
6. List of CMR's staff assignments.
7. Copies of demolition and/or building permits (if required).
8. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
9. Certificates of insurance and insurance policies.

H. Application for Payment at Beneficial Occupancy: After Architect issues the Certificate of Final Acceptance, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as complete.

1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.

I. Final Payment Application: After completing Project Closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:

1. Evidence of completion of Project closeout requirements.
2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
3. Updated final statement, accounting for final changes to the Contract Sum.
4. Certificates of Release: From authorities having jurisdiction.
5. Certificate of Insurance: For continuing coverage.
6. Project Approval Authorization; Partial Utilization (Beneficial Occupancy)
7. Project Approval Authorization; Final Inspection for Owner Occupancy.
8. Certificate of Compliance.
9. Certificate of Completion.
10. Evidence that claims have been settled.
11. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Beneficial Occupancy or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
12. Final liquidated damages settlement statement.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012900

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:

1. Coordination drawings.
2. Requests for Information (RFIs).
3. Project meetings.

B. Related Requirements:

1. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.

1.2 DEFINITIONS

A. RFI: Request from Owner, Architect, or CMR seeking information required by or clarifications of the Contract Documents.

1.3 INFORMATIONAL SUBMITTALS

A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:

1. Name, address, and telephone number of entity performing subcontract or supplying products.
2. Number and title of related Specification Section(s) covered by subcontract.
3. Drawing number and detail references, as appropriate, covered by subcontract.

1.4 GENERAL COORDINATION PROCEDURES

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.

B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.

C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of CMR's construction schedule.
2. Preparation of the schedule of values.
3. Installation and removal of temporary facilities and controls.
4. Delivery and processing of submittals.
5. Progress meetings.
6. Project closeout activities.
7. Startup and adjustment of systems.

1.5 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.

1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:

   a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
   b. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

B. Coordination Drawing Organization: Organize coordination drawings as follows:

1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid.
2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within ceiling plenum to accommodate layout of light fixtures indicated on Drawings.
3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.

6. Review: Architect will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are CMR's responsibility.

1.6 REQUESTS FOR INFORMATION (RFIs)

A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, CMR shall prepare and submit an RFI in the form specified.

1. Architect will return RFIs submitted to Architect by other entities controlled by CMR with no response.
2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in CMR's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:

1. Project name.
2. Project number.
3. Date.
4. Name of CMR.
5. Name of Architect.
6. RFI number, numbered sequentially.
7. RFI subject.
8. Specification Section number and title and related paragraphs, as appropriate.
9. Drawing number and detail references, as appropriate.
10. Field dimensions and conditions, as appropriate.
11. Contractor's suggested resolution. If CMR's solution(s) impacts the Contract Time or the Contract Sum, CMR shall state impact in the RFI.
12. Contractor's signature.
13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

C. RFI Forms: AIA Document G716.

D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow seven working days for Architect's response for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.

1. The following RFIs will be returned without action:

    a. Requests for approval of submittals.
    b. Requests for approval of substitutions.
    c. Requests for coordination information already indicated in the Contract Documents.
    d. Requests for adjustments in the Contract Time or the Contract Sum.
    e. Requests for interpretation of Architect's actions on submittals.
    f. Incomplete RFIs or inaccurately prepared RFIs.

2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt of additional information.
3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."

a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 10 days of receipt of the RFI response.

E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log 3 working days prior to the Monthly Project Meeting. Include the following:

1. Project name.
2. Name and address of CMR.
3. Name and address of Architect.
4. RFI number including RFIs that were dropped and not submitted.
5. RFI description.
6. Date the RFI was submitted.
7. Date Architect's response was received.

F. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within seven days if CMR disagrees with response.

1. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
2. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

1.7 PROJECT MEETINGS

A. General: Architect will schedule and conduct Monthly Project Meetings and conferences at Project site unless otherwise indicated.

B. Preconstruction Conference: Architect will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than 15 days after execution of the Agreement. The Architect will prepare and distribute Meeting Minutes to Attendees.

1. Attendees: Authorized representatives of Owner, Architect, and their consultants; CMR and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Discuss items of significance that could affect progress, including the following:

a. Tentative construction schedule.
b. Phasing.
c. Critical work sequencing and long-lead items.
d. Designation of key personnel and their duties.
e. Procedures for processing field decisions and Change Orders.
f. Procedures for RFIs.
g. Procedures for testing and inspecting.
h. Procedures for processing Applications for Payment.
i. Distribution of the Contract Documents.
j. Submittal procedures.
k. Preparation of record documents.
l. Use of the premises and existing buildings.
m. Work restrictions.
n. Working hours.

o. Owner's occupancy requirements.
p. Responsibility for temporary facilities and controls.
q. Procedures for moisture and mold control.
r. Procedures for disruptions and shutdowns.
s. Construction waste management and recycling.
t. Parking availability.
u. Office, work, and storage areas.
v. Equipment deliveries and priorities.
w. First aid.
x. Security.
y. Progress cleaning.

C. Pre-installation Conferences: Conduct a pre-installation conference at Project site before each construction activity that requires coordination with other construction.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect of scheduled meeting dates.
2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:

a. Contract Documents.
b. Options.
c. Related RFIs.
d. Related Change Orders.
e. Purchases.
f. Deliveries.
g. Submittals.
h. Possible conflicts.
i. Compatibility problems.
j. Time schedules.
k. Manufacturer's written instructions.
l. Warranty requirements.
m. Compatibility of materials.
n. Acceptability of substrates.
o. Temporary facilities and controls.
p. Space and access limitations.
q. Regulations of authorities having jurisdiction.
r. Testing and inspecting requirements.
s. Installation procedures.
t. Coordination with other work.
u. Required performance results.
v. Protection of adjacent work.
w. Protection of construction and personnel.

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

A. Progress Meetings: Architect will conduct progress meetings at monthly intervals. The Architect will prepare and distribute Meeting Minutes to Attendees.

1. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

    a. CMR's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to CMR's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

        1) Review schedule for next period.

    b. Review present and future needs of each entity present, including the following:

        1) Interface requirements.
        2) Sequence of operations.
        3) Status of submittals.
        4) Deliveries.
        5) Off-site fabrication.
        6) Access.
        7) Site utilization.
        8) Temporary facilities and controls.
        9) Progress cleaning.
        10) Quality and work standards.
        11) Status of correction of deficient items.
        12) Field observations.
        13) Status of RFIs.
        14) Status of proposal requests.
        15) Pending changes.
        16) Status of Change Orders.
        17) Pending claims and disputes.
        18) Documentation of information for payment requests.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. CMR's construction schedule.
2. Construction schedule updating reports.
3. Daily construction reports.

1.2 DEFINITIONS

A. Schedule: The time required to complete the work of this Contract. This is not to be construed as the same as the Contract Time, which is established by the Designer, and is intended to allow for normal weather delays, unforeseen conditions, inspections delays, et cetera, and does not represent the time it should take to complete the work.

B. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.

1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
2. Predecessor Activity: An activity that precedes another activity in the network.
3. Successor Activity: An activity that follows another activity in the network.

C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.

D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.

E. Float: The measure of leeway in starting and completing an activity.

1. Float time is not for the exclusive use or benefit of either Owner or CMR, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones, Beneficial Occupancy and Contract Completion date. No time extensions will be allowed if it can be demonstrated that the Work can reasonably be completed within the scheduled time.

1.3 INFORMATIONAL SUBMITTALS

A. Format for Submittals: Submit required submittals in the following format:

1. PDF electronic file.

B. CMR's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.

C. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.

1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.

D. Construction Schedule Updating Reports: Submit at Monthly progress Meeting.

E. Daily Construction Reports: Maintain log on Project Site.

PART 2 - PRODUCTS

2.1 CMR'S CONSTRUCTION SCHEDULE, GENERAL

A. Time Frame: Extend schedule from date established for the Notice of Award to date of final completion.

1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

B. Activities: Treat each story or separate area as a separate numbered activity for each main element of the Work. Comply with the following:

1. Activity Duration: Define activities so no activity is longer than 10 days, unless specifically allowed by Architect.
2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
3. Submittal Review Time: Include review and resubmittal times indicated in Section 013300 "Submittal Procedures" in schedule. Coordinate submittal review times in CMR's construction schedule with submittal schedule.
4. Startup and Testing Time: Include no fewer than 5 days for startup and testing.
5. Beneficial Occupancy: Indicate completion in advance of date established for Beneficial Occupancy, and allow time for Architect's administrative procedures necessary for certification of Beneficial Occupancy.
6. Punch List and Final Completion: Include not more than 10 days for completion of punch list items and final completion.

C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.

1. Phasing: Arrange list of activities on schedule by phase.
2. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
3. Work Restrictions: Show the effect of the following items on the schedule:

a. Coordination with existing construction.

b. Limitations of continued occupancies.
c. Uninterruptible services.
d. Partial occupancy before Final Completion.
e. Use of premises restrictions.
f. Environmental control.

4. Work Stages: Indicate important stages of construction for each major portion of the Work.

D. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Beneficial Occupancy for each Phase, and final completion.

E. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:

1. Unresolved issues.
2. Unanswered Requests for Information.
3. Rejected or unreturned submittals.
4. Notations on returned submittals.
5. Pending modifications affecting the Work and Contract Time.

F. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule.

G. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.

2.2 CMR'S CONSTRUCTION SCHEDULE (GANTT CHART)

A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's construction schedule within 21 days of date established for the Notice of Award.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.

1. For construction activities that require three months or longer completing, indicate an estimated completion percentage in 20 percent increments within time bar.

2.3 CMR'S CONSTRUCTION SCHEDULE (CPM SCHEDULE)

A. General: Prepare network diagrams using AON (activity-on-node) format.

B. CPM Schedule: Prepare CMR's construction schedule using a time-scaled CPM network analysis diagram for the Work.

1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 14 days after date established for the Notice of Award.

a. Failure to include any work item required for performance of this Contract shall not excuse CMR from completing all work within applicable completion dates, regardless of Architect's approval of the schedule.

2. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
3. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule in order to coordinate with the Contract Time.

C. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the startup network diagram, prepare a skeleton network to identify probable critical paths.

1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:

    a. Preparation and processing of submittals.
    b. Mobilization and demobilization.
    c. Purchase of materials.
    d. Delivery.
    e. Fabrication.
    f. Utility interruptions.
    g. Installation.
    h. Work by Owner that may affect or be affected by CMR's activities.
    i. Testing.
    j. Punch list, Beneficial Occupancy and final completion.
    k. Activities occurring following final completion.

2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.

D. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall project schedule.

E. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start-total float." Identify critical activities. Prepare tabulated reports showing the following:

1. CMR or subcontractor and the Work or activity.
2. Description of activity.
3. Main events of activity.
4. Immediately preceding and succeeding activities.
5. Early and late start dates.
6. Early and late finish dates.
7. Activity duration in workdays.
8. Total float or slack time.
9. Average size of workforce.
10. Dollar value of activity (coordinated with the schedule of values).

F. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:

1. Identification of activities that have changed.
2. Changes in early and late start dates.
3. Changes in early and late finish dates.
4. Changes in activity durations in workdays.
5. Changes in the critical path.
6. Changes in total float or slack time.
7. Changes in the Contract Time.

2.4 REPORTS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:

1. List of subcontractors at Project site.
2. List of separate subcontractors at Project site.
3. Approximate count of personnel at Project site.
4. Equipment at Project site.
5. Material deliveries.
6. Accidents.
7. Meetings and significant decisions.
8. Unusual events.
9. Stoppages, delays, shortages, and losses.
10. Orders and requests of authorities having jurisdiction.
11. Change Orders received and implemented.
12. Change Directives received and implemented.
13. Services connected and disconnected.
14. Equipment or system tests and startups.
15. Partial completions and occupancies.
16. Beneficial Occupancy authorized.

PART 3 - EXECUTION

3.1 CMR'S CONSTRUCTION SCHEDULE

A. CMR's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule at each regularly scheduled progress meeting.

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
3. As the Work progresses, indicate final completion percentage for each activity.

B. Distribution: Distribute copies of approved schedule to Architect, Owner, testing and inspecting agencies, and other parties identified by CMR with a need-to-know schedule responsibility.

1. Post copies in Project meeting rooms and temporary field offices.
2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their

assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION 013200

SECTION 013233 - PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for the following:

1. Preconstruction photographs and/or video.

1.2 INFORMATIONAL SUBMITTALS

A. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each **photograph** or **video recording**. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.

B. Digital Photographs: Submit unaltered, original, full-size image files within seven (7) days of taking photographs.

1. Digital Camera: Minimum sensor resolution of twelve (12) megapixels.
2. Identification: Provide the following information with each image description in file metadata tag:

a. Name of Project.
b. Name and contact information for photographer.
c. Date photograph was taken.
d. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.

PART 2 - PRODUCTS

2.1 PHOTOGRAPHIC MEDIA

A. Digital Images: Provide images in JPG format, with minimum size of five (5) megapixels.

PART 3 - EXECUTION

3.1 CONSTRUCTION PHOTOGRAPHS

A. General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.

1. Maintain key plan with each set of construction photographs that identifies each photographic location.

B. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.

1. Date and Time: Include date and time in file name for each image.
2. Field Office Images: Maintain one set of images accessible in the field office at Project site, available at all times for reference.

C. Preconstruction Photographs: Before **commencement of demolition**, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points.

1. Flag **construction limits** before taking construction photographs.
2. Take 30 photographs to show existing conditions adjacent to **construction limits** before starting the Work.
3. Take 30 photographs of existing buildings to accurately record physical conditions at start of construction.

END OF SECTION 013233

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

B. Related Requirements:

1. Section 013200 "Construction Progress Documentation" for submitting schedules and reports, including CMR's construction schedule.
2. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.

1.2 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action.

B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements.

1.3 ACTION SUBMITTALS

A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and additional time for handling and reviewing submittals required by those corrections. This information should be incorporated into the Construction Schedule.

B. All Product Submittals must be scheduled for Designer review within 30 days of Notice to Proceed.

1.4 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. Architect's Digital Data Files: If requested, electronic copies of digital data files of the Contract Drawings will be provided by Architect for CMR's use in preparing submittals.

1. Architect will furnish CMR one set of digital data drawing files of the Contract Drawings for use in preparing Shop Drawings and Project record drawings.

    a. Architect makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

    a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
    b. Submit the entire building system as one submittal: i.e.: for masonry, provide submittals for accessories, mortar, flashings, masonry materials, etc.; for roofing, provide submittals for roof covering, underlayments, flashing materials, rain drainage, etc.

C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

1. Initial Review: Allow 7 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required or if Architect's consultants must also review the submittal. Architect will advise CMR when a submittal being processed must be delayed for coordination.
2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
3. Resubmittal Review: Allow 5 days for review of each resubmittal.

D. Paper Submittals: ***(Do not use this format unless the Subcontractor or vendor does not have the capability to use electronic format).***

General: Place a permanent label or title block on each submittal item for identification.

1. Indicate name of firm or entity that prepared each submittal on label or title block.
2. Architect will place his Action Taken Stamp on the Transmittal Letter for returning the Submittal.
3. Include the following information for processing and recording action taken:

    a. Project name.
    b. Date.
    c. Name of Architect.
    d. Name of Construction Manager at Risk (CMR).
    e. Name of subcontractor.
    f. Name of supplier.
    g. Name of manufacturer.
    h. Submittal number or other unique identifier, including revision identifier.

        1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 061000.01.A).

    i. Number and title of appropriate Specification Section.
    j. Drawing number and detail references, as appropriate.
    k. Location(s) where product is to be installed, as appropriate.
    l. Other necessary identification.

4. Additional Paper Copies: Unless additional copies are required for final submittal, and unless Architect observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.

   a. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Architect.

5. Transmittal for Paper Submittals: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Architect will discard submittals received from sources other than CMR.

   a. Transmittal Form for Paper Submittals: Use facsimile of sample form included at the end of this Section.
   b. Transmittal Form for Paper Submittals: Provide locations on form for the following information:

      1) Project name.
      2) Date.
      3) Destination (To:).
      4) Source (From:).
      5) Name and address of Architect.
      6) Name of CMR.
      7) Name of Sub-Contractor.
      8) Name of firm or entity that prepared submittal.
      9) Names of subcontractor, manufacturer, and supplier.
      10) Category and type of submittal.
      11) Submittal purpose and description.
      12) Specification Section number and title.
      13) Specification paragraph number or drawing designation and generic name for each of multiple items.
      14) Drawing number and detail references, as appropriate.
      15) Indication of full or partial submittal.
      16) Transmittal number, numbered consecutively.
      17) Submittal and transmittal distribution record.
      18) Remarks.
      19) Signature of transmitter.

E. Electronic Submittals: ***Preferred form of Submittal.***

General: Identify and incorporate information in each electronic submittal file as follows:

1. All Electronic Submittals to the Design Team shall be in PDF format. Contractor's Management Software does not apply to the communications with the Design Team. Items requiring primary review by professional license holders on the Design Team ***other than the Architect*** must be emailed directly to that professional and an email copy shall be sent to the Architect. The professional will return the submittals with marking and copy the Architect.
2. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
3. Name file with submittal number or other unique identifier, including revision identifier.

   a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).

4. Provide means for insertion to permanently record CMR's review and approval markings and action taken by Architect.
5. Transmittal Form for Electronic Submittals: Use form at the end of this Section.

F. Options: Identify options requiring selection by Architect.

G. Deviations: Identify deviations from the Contract Documents on submittals.

H. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block and clearly indicate extent of revision.
3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.

I. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

J. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

A. **Submittal Procedures simplified:** PART 1 of each Specification Section includes a subparagraph “SUBMITTALS”. Provide all of the information required in that subparagraph at one time. PART 2 of each Specification Section is labeled “PRODUCTS”. Highlight or underline in your submittal each product you intend to use. *Do not send extraneous information pertaining to products not specified.*

B. General Submittal Procedure Requirements:

1. ***Submit complete package for each building system at one time. Preference is for electronic submittal only (exception: provide one set of samples, listed on the electronic submittal and parcel posted the same day).***
2. ***Submit electronic submittals via email as PDF electronic files.***

    a. Architect will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.

3. ***Submit to the Consultant who is responsible for the Division of Work covered by the Submittal and provide the Architect with a Copy of that submittal.***
4. Action Submittals: Submit 2 paper copies (plus 1, for Architect Consultant Review) of each submittal unless otherwise indicated. Architect will return 1 copy.
5. Informational Submittals: Submit 1 paper copy (plus 1, for Architect Consultant Review) of each submittal unless otherwise indicated. Architect will not return copies.
6. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.

a. Provide a digital signature with digital certificate on electronically-submitted certificates and certifications where indicated.
b. Provide a notarized statement on original paper copy certificates and certifications where indicated.

C. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
2. Mark each copy of each submittal to show which products and options are applicable.
3. Include the following information, as applicable:

a. Manufacturer's catalog cuts.
b. Manufacturer's product specifications.
c. Standard color charts.
d. Statement of compliance with specified referenced standards.
e. Testing by recognized testing agency.
f. Application of testing agency labels and seals.
g. Notation of coordination requirements.
h. Availability and delivery time information.

4. For equipment, include the following in addition to the above, as applicable:

a. Wiring diagrams showing factory-installed wiring.
b. Printed performance curves.
c. Operational range diagrams.
d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.

5. Submit Product Data in the following format:

a. PDF electronic file, preferred, or:
b. 1 paper copy (plus 1, for Architect Consultant Review) of Product Data unless otherwise indicated. Architect will not return any copies, but will comment via electronic transmittal.

D. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data, unless submittal based on Architect's digital data drawing files is otherwise permitted.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

a. Identification of products.
b. Schedules.
c. Compliance with specified standards.
d. Notation of coordination requirements.
e. Notation of dimensions established by field measurement.
f. Relationship and attachment to adjoining construction clearly indicated.
g. Seal and signature of professional engineer if specified.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches (215 by 280 mm), but no larger than 30 by 42 inches (750 by 1067 mm).

3. Submit Shop Drawings in the following format:

    a. PDF electronic file (preferred) or:
    b. Two opaque (bond) copies (plus 1, for Architect Consultant Review) of each submittal. Architect will return one copy.

E. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed. ***When providing samples that match the Designer's selection deliver them to the Project Site and not to the Designer.***

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
2. Identification: Attach label on unexposed side of Samples that includes the following:

    a. Generic description of Sample.
    b. Product name and name of manufacturer.
    c. Sample source.
    d. Number and title of applicable Specification Section.

3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

    a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
    b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of CMR

5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.

    a. Number of Samples: Submit one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will not return submittal, but will designate options selected via email.

6. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

    a. Number of Samples: Retain samples at the Project Site.

        1) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, provide at least 3 sets of paired units that show approximate limits of variations.

F. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:

1. Submit product schedule in the following format:

a. PDF electronic file (preferred), or:
b. 2 paper copies (plus 1, for Architect Consultant Review) of product schedule or list unless otherwise indicated. Architect will scan and return an electronic copy.

G. Coordination Drawings Submittals: Comply with requirements specified in Section 013100 "Project Management and Coordination."

H. CMR's Construction Schedule: Comply with requirements specified in Section 013200 "Construction Progress Documentation."

I. Application for Payment and Schedule of Values: Comply with requirements specified in Section 012900 "Payment Procedures.

J. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 017700 "Closeout Procedures."

K. Maintenance Data: Comply with requirements specified in Section 017823 "Operation and Maintenance Data."

L. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.

M. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.

N. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

O. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.

P. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.

Q. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.

R. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.

S. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation

of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

T. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project.

U. Schedule of Tests and Inspections: Comply with requirements specified in Section 014000 "Quality Requirements."

V. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.

W. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

X. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.

Y. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

2.2 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of CMR by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.

B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF electronic file of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

A. Action and Informational Submittals: ***Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note***

corrections and field dimensions. Mark and date with approval stamp before submitting to Architect.

B. Project Closeout and Maintenance Material Submittals: See requirements in Section 017700 "Closeout Procedures."

C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of CMR's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ARCHITECT'S ACTION

A. General: Architect will not review submittals that do not bear CMR's approval stamp and will return them without action.

B. Action Submittals: Architect will review each submittal, make marks to indicate corrections or revisions required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.

C. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.

D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will not be returned.

E. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

F. Submittals that are not satisfactory after one Re-submittal may be subject to a charge for the time required by the designer to review it again. That charge will be for actual cost of the work, per the Designers' standard hourly rates.

3.3 DOCUMENTS REQUIRED TO BE AVAILABLE ON SITE

A. The CMR must provide a complete full size paper set of each approved submittal in the Project Office, to assure the Designers' instructions have been transmitted to the Superintendent and the installers.

END OF SECTION 013300

SZOSTAK

310 1/2 West Franklin Street/Chapel Hill, NC 27516 www.szostakdesign.com T 919 929 5244 F 919 960 7967

Submittal Cover Sheet

Project: Ft. Fisher Aquarium – Renovations and Additions

CMR: Clancy & Theys Construction Company
2250 Shipyard Blvd, Suite One
Wilmington, NC 28403

Submittal Information:

Specification Section:_____
Product Name:_____
Subcontractor:_____
Supplier:_____
Manufacturer:_____

Submittal Type:

___Samples	___Test Reports	___Qualification Data
___Warranties	___Research Reports	___Coordination Drawings
___Product Data	___Maintenance Instructions	___Shop Drawings
___Certificates	___Schedules	___Record Drawings

Architect/Engineer Review:

Comments:

Submitted in accordance with the Contract Documents.

Submittal No. _____

Approved by: _____

Date: _____

SECTION 014110 – special Inspections

Statement of Special Inspections

Project: Fort Fisher Aquarium Renovation & Expansion – Phase 1
Location: 900 Loggerhead Rd, Kure Beach, NC 28449
Owner's Representative: James Mancari
Owner's Address: 3125 Poplarwood Ct, Suite 160, Raleigh, NC 27604

This Statement of Special Inspections is submitted as a condition for permit issuance in accordance with the Special Inspection requirements of the 2018 North Carolina State Building Code. It includes a Schedule of Special Inspection Services applicable to this project (refer to S-010 and G-1.24), the name of the Special Inspector, the identity of other approved agencies retained for conducting Special Inspections, and the required inspector qualifications. This Statement of Special Inspections was prepared by the following Designers of Record:

Structural	Klaus Perkins		
	(Type or print name)	(Signature)	(Date)
Architectural	Phil Szostak		
	(Type or print name)	(Signature)	(Date)
Mechanical			
	(Type or print name)	(Signature)	(Date)
Other			
	(Type or print name)	(Signature)	(Date)

The Special Inspector shall keep records of all special inspections and tests and shall furnish reports to the State Construction Office and the Designers of Record. Reports shall indicate if the work inspected or tested was or was not completed in conformance with the approved construction documents. Discovered discrepancies shall be brought to the immediate attention of the Contractor for correction. If such discrepancies are not corrected, the discrepancies shall be brought to the attention of the State Construction Office and the Designers of Record. The Special Inspections program does not relieve the Contractor of his or her responsibilities.

Interim reports shall be submitted to the State Construction Office, Owner, and the Designers of Record.

Interim Report Frequency: Monthly

A Final Report of Special Inspections documenting completion of all required Special Inspections, testing, and correction of any discrepancies should be submitted prior to issuance of a Certificate of Use and Occupancy.

Job Site safety and means and methods of construction are solely the responsibility of the Contractor.

Owner's Authorization

Signature Date

Accepted for the SCO by:

Signature Date

END OF SECTION

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

B. Related Requirements:

1. Section 011000 "Summary" for work restrictions and limitations on utility interruptions.

1.2 USE CHARGES

A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to testing agencies and authorities having jurisdiction.

B. Water Service: Water will become available as part of this project. Until it is available for use provide water as required for construction operations.

1.3 INFORMATIONAL SUBMITTALS

A. Site Plan: When facilities are known, show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel. Distribute copies of this to all personnel and subcontractors.

B. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate CMR personnel responsible for management of fire prevention program.

1.4 QUALITY ASSURANCE

A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

C. Accessible Temporary Egress: Comply with applicable provisions in ICC/ANSI A117.1.

1.5 PROJECT CONDITIONS

A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.1 TEMPORARY FACILITIES

A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.

B. Common-Use Field Office: Of sufficient size to accommodate needs of Owner, Architect, and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly.

C. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

2.2 EQUIPMENT

A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system (where it may be available), provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.

1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
2. Heating Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
3. Permanent HVAC System: Use permanent HVAC system for temporary use during construction when it becomes available, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction and clean HVAC system as required in Section 017700 "Closeout Procedures".

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.

B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

A. General: Install temporary service.

1. Arrange to make connections for temporary services at the earliest time required to provide service to all subcontractors.

B. Water Service: Make arrangements for use of existing water service on site for all subcontractors.

C. Sanitary Facilities: Provide temporary toilets, for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

D. Electric Power Service: Make arrangements for use of Owner's existing electric power service. Verify that it is of sufficient size, capacity, and power characteristics required for construction operations.

E. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.

1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

F. Telephone Service: Provide the CMR Superintendent with a cellular phone the can receive emails and text messages as well as voice mail.

G. Electronic Communication Service: Provide a desktop computer or laptop computer in the primary field office adequate for use by Architect and Owner to access project electronic documents and maintain electronic communications. Equip computer with not less than the following:

Processors: AMD Ryzen 5000 or Intel 11th Gen (for onboard video, no GPU, Ryzen 7000 or specifically 5000 G series)
GPU: if not using onboard video or in need of more graphics power use RTX A2000 or newer
Memory: 16-gigabyte.
Disk Storage: 1TB SSD.
Display: 24-inch
Network Connectivity: 1000 BaseT Ethernet.
Software: Windows 11 Pro, Adobe Acrobat DC or Pro, Microsoft Office 2021 or M365
Printer: "All-in-one" unit combining color printing, photocopying, scanning, and faxing
Internet Service: Cable or Fiber
Internet Security: Built-In Windows Defender or Bitdefender

3.3 SUPPORT FACILITIES INSTALLATION

A. General: Comply with the following:

1. Maintain support facilities until Architect schedules Beneficial Occupancy inspection. Remove before Beneficial Occupancy. Personnel remaining after Beneficial Occupancy will be permitted to use permanent facilities, under conditions acceptable to Owner.

B. Parking: Temporary parking areas for construction personnel will be elsewhere on the Aquarium Property as directed by the Owner.

C. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 017300 "Execution."

D. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.

1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.

B. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting. Use high visibility warning tape and wood or metal stakes to separate construction area from remainder of campus.

C. Temporary Egress: Maintain temporary egress from existing occupied facilities as required by authorities having jurisdiction.

D. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate demolition area from area occupied by Owner from fumes and noise.

E. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire prevention program.

1. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
2. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. If using fire-suppression sprinkler systems or other permanent fire-protection systems, insert specific requirements.

3.5 MOISTURE AND MOLD CONTROL

A. Contractor's Moisture Protection Plan: Avoid trapping water in finished work. Document visible signs of mold that may appear during construction.

3.6 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Maintenance: Maintain facilities in good operating condition until removal.

1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Beneficial Occupancy.

D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Beneficial Occupancy. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are property of Contractor.
2. At Beneficial Occupancy, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

1

2 END OF SECTION 015000

SECTION 015639 - TEMPORARY TREE AND PLANT PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes general protection and pruning of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for temporary site fencing.
2. Section 311000 "Site Clearing" for removing existing trees and shrubs.

1.3 DEFINITIONS

A. Caliper: Diameter of a trunk measured by a diameter tape at a height 6 inches (150 mm) above the ground for trees up to and including 4-inch (100-mm) size at this height and as measured at a height of 12 inches (300 mm) above the ground for trees larger than 4-inch (100-mm) size.

B. Caliper (DBH): Diameter breast height; diameter of a trunk as measured by a diameter tape at a height 54 inches (1372 mm) above the ground line for trees with caliper of 8 inches (200 mm) or greater as measured at a height of 12 inches (300 mm) above the ground.

C. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.

D. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and indicated on Drawings.

E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to temporary tree and plant protection including, but not limited to, the following:

    a. Tree-service firm's personnel, and equipment needed to make progress and avoid delays.
    b. Arborist's responsibilities.
    c. Quality-control program.

d. Coordination of Work and equipment movement with the locations of protection zones.
e. Trenching by hand or with air spade within protection zones.
f. Field quality control.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include plans, elevations, sections, and locations of protection-zone fencing and signage, showing relation of equipment-movement routes and material storage locations with protection zones.
2. Detail fabrication and assembly of protection-zone fencing and signage.
3. Indicate extent of trenching by hand or with air spade within protection zones.

C. Samples: For each type of the following:

1. Organic Mulch: 1-quart (1-L) volume of organic mulch; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch.
2. Protection-Zone Fencing: Assembled Samples of manufacturer's standard size made from full-size components.
3. Protection-Zone Signage: Full-size Samples of each size and text, ready for installation.

D. Tree Pruning Schedule: Written schedule detailing scope and extent of pruning of trees to remain that interfere with or are affected by construction.

1. Species and size of tree.
2. Location on site plan. Include unique identifier for each.
3. Reason for pruning.
4. Description of pruning to be performed.
5. Description of maintenance following pruning.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For arborist and tree service firm.

B. Certification: From arborist, certifying that trees indicated to remain have been protected during construction according to recognized standards and that trees were promptly and properly treated and repaired when damaged.

C. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.

D. Existing Conditions: Documentation of existing trees and plantings indicated to remain, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.

1. Use sufficiently detailed photographs or video recordings.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

E. Quality-control program.

1.7 QUALITY ASSURANCE

A. Arborist Qualifications: Certified Arborist as certified by ISA and licensed arborist in jurisdiction where Project is located.

B. Tree Service Firm Qualifications: An experienced tree service firm that has successfully completed temporary tree and plant protection work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.

C. Quality-Control Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work without damaging trees and plantings. Inc

D. lude dimensioned diagrams for placement of protection zone fencing and signage, the arborist's and tree-service firm's responsibilities, instructions given to workers on the use and care of protection zones, and enforcement of requirements for protection zones.

1.8 FIELD CONDITIONS

A. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Moving or parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

B. Do not direct vehicle or equipment exhaust toward protection zones.

C. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones and organic mulch.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Backfill Soil: Planting soil of suitable moisture content and granular texture for placing around tree; free of stones, roots, plants, sod, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth.
1. Planting Soil: Planting soil as specified in Section 329300 "Plants".

B. Organic Mulch: Free from deleterious materials and suitable as a top dressing for trees and shrubs, consisting of one of the following:

1. Mulch: Mulch as specified in Section 329300 “Plants”.

C. Plastic Protection-Zone Fencing: Fencing fixed in position and meeting the following requirements:

1. Plastic Protection-Zone Fencing: Plastic construction fencing constructed of high-density extruded and stretched polyethylene fabric with 2-inch (50-mm) maximum opening in pattern and weighing a minimum of 0.4 lb/ft. (0.6 kg/m); remaining flexible from minus 60 to plus 200 deg F (minus 16 to plus 93 deg C); inert to most chemicals and acids; minimum tensile yield strength of 2000 psi (13.8 MPa) and ultimate tensile strength of 2680 psi (18.5 MPa); secured with plastic bands or galvanized-steel or stainless-steel wire ties; and supported by tubular or T-shape galvanized-steel posts spaced not more than 96 inches (2400 mm) apart.

a. Height: 48 inches (1800 mm).

2. Gates: Single swing access gates matching material and appearance of fencing, to allow for maintenance activities within protection zones; leaf width minimum 36 inches (914 mm).

D. Protection-Zone Signage: Shop-fabricated, rigid plastic or metal sheet with attachment holes pre-punched and reinforced; legibly printed with nonfading lettering and as follows:

1. Size and Text: As shown on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

B. Prepare written report, endorsed by arborist, listing conditions detrimental to tree and plant protection.

3.2 PREPARATION

A. Locate and clearly identify trees, shrubs, and other vegetation to remain. Tie a 1-inch (25-mm) blue vinyl tape around each tree trunk at 54 inches (1372 mm) above the ground.

B. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.

C. Tree-Protection Zones: Mulch areas inside tree-protection zones and other areas indicated. Do not exceed indicated thickness of mulch.

1. Apply 4-inch (100-mm) uniform thickness of organic mulch unless otherwise indicated. Do not place mulch within 6 inches (150 mm) of tree trunks.

3.3 PROTECTION ZONES

A. Protection-Zone Fencing: Install protection-zone fencing along edges of protection zones before materials or equipment are brought on the site and construction operations begin in a manner that will prevent people and animals from easily entering protected areas except by entrance gates. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation.

1. Chain-Link Fencing: Install to comply with ASTM F 567 and with manufacturer's written instructions.
2. Posts: Set or drive posts into ground one-third the total height of the fence without concrete footings. Where a post is located on existing paving or concrete to remain, provide appropriate means of post support acceptable to Architect.
3. Access Gates: Install where indicated adjust to operate smoothly, easily, and quietly; free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Protection-Zone Signage: Install protection-zone signage in visibly prominent locations in a manner approved by Architect. Install one sign spaced approximately every 50 feet (15 m) on protection-zone fencing, but no fewer than four signs with each facing a different direction.

C. Maintain protection zones free of weeds and trash.

D. Maintain protection-zone fencing and signage in good condition as acceptable to Architect and remove when construction operations are complete and equipment has been removed from the site.

1. Do not remove protection-zone fencing, even temporarily, to allow deliveries or equipment access through the protection zone.
2. Temporary access is permitted subject to preapproval in writing by arborist if a root buffer effective against soil compaction is constructed as directed by arborist. Maintain root buffer so long as access is permitted.

3.4 EXCAVATION

A. General: Excavate at edge of protection zones and for trenches indicated within protection zones according to requirements in Section 312000 "Earth Moving" unless otherwise indicated.

B. Trenching within Protection Zones: Where utility trenches are required within protection zones, excavate under or around tree roots by hand or with air spade, or tunnel under the roots by drilling, auger boring, or pipe jacking. Do not cut main lateral tree roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots as required for root pruning. If excavating by hand, use na

C. rrow-tine spading forks to comb soil and expose roots.

D. Redirect roots in backfill areas where possible. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking. If encountered immediately adjacent to location of new construction and redirection is not practical, cut roots approximately 3 inches (75 mm) back from new construction and as required for root pruning.

E. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

3.5 ROOT PRUNING

A. Prune tree roots that are affected by temporary and permanent construction. Prune roots as follows:

1. Cut roots manually by digging a trench and cutting exposed roots with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
2. Cut Ends: Do not paint cut root ends.
3. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
4. Cover exposed roots with burlap and water regularly.
5. Backfill as soon as possible according to requirements in Section 312000 "Earth Moving."

B. Root Pruning at Edge of Protection Zone: Prune tree roots flush with the edge of the protection zone by cleanly cutting all roots to the depth of the required excavation.

C. Root Pruning within Protection Zone: Clear and excavate by hand or with air spade to the depth of the required excavation to minimize damage to tree root systems. If excavating by hand, use narrow-tine spading forks to comb soil to expose roots. Cleanly cut roots as close to excavation as possible.

3.6 CROWN PRUNING

A. Prune branches that are affected by temporary and permanent construction. Prune branches under direction of arborist.

1. Prune to remove only injured, broken, dying, or dead branches unless otherwise indicated. Do not prune for shape unless otherwise indicated.
2. Do not remove or reduce living branches to compensate for root loss caused by damaging or cutting root system.
3. Pruning Standards: Prune trees according to ANSI A300 (Part 1) and as indicated on Drawings.

    a. Type of Pruning: Cleaning, raising, reducing, and thinning where indicated.
    b. Specialty Pruning: Structural, restoration and utility where indicated.

B. Unless otherwise directed by arborist and acceptable to Architect, do not cut tree leaders.

C. Cut branches with sharp pruning instruments; do not break or chop.

D. Do not paint or apply sealants to wounds.

E. Provide subsequent maintenance pruning during Contract period as recommended by arborist.

F. Chip removed branches and dispose of off-site unless requested for compost or mulch by Owner.

3.7 REGRADING

A. Lowering Grade: Where new finish grade is indicated below existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.

B. Lowering Grade within Protection Zone: Where new finish grade is indicated below existing grade around trees, slope grade away from trees as recommended by arborist unless otherwise indicated.

1. Root Pruning: Prune tree roots exposed by lowering the grade. Do not cut main lateral roots or taproots; cut only smaller roots. Cut roots as required for root pruning.

C. Raising Grade: Where new finish grade is indicated above existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.

D. Minor Fill within Protection Zone: Where existing grade is 2 inches (50 mm) or less below elevation of finish grade, fill with backfill soil. Place backfill soil in a single uncompacted layer and hand grade to required finish elevations.

3.8 FIELD QUALITY CONTROL

A. Inspections: Engage a qualified arborist to direct plant-protection measures in the vicinity of trees, shrubs, and other vegetation indicated to remain and to prepare inspection reports.

3.9 REPAIR AND REPLACEMENT

A. General: Repair or replace trees, shrubs, and other vegetation indicated to remain or to be relocated that are damaged by construction operations, in a manner approved by Architect.

1. Submit details of proposed pruning and repairs.
2. Perform repairs of damaged trunks, branches, and roots within 24 hours according to arborist's written instructions.
3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.

B. Trees: Remove and replace trees indicated to remain that are more than 25 percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern.

1. Small Trees: Provide new trees of same size and species as those being replaced for each tree that measures 4 inches (100 mm) or smaller in caliper size.
2. Large Trees: Provide new tree(s) of 6-inch (150-mm) caliper size for each tree being replaced that measures more than 6 inches (150 mm) in caliper size, in increments of 6-inch caliper such that the cumulative caliper inch meets or exceeds that of the tree removed.

    a. Species: As selected by Architect.

3. Plant and maintain new trees as specified in Section 329300 "Plants."

C. Excess Mulch: Rake mulched area within protection zones, being careful not to injure roots. Rake to loosen and remove mulch that exceeds a 4-inch (100-mm) uniform thickness to remain.

D. Soil Aeration: Where directed by Architect, aerate surface soil compacted during construction. Aerate 10 feet (3 m)] beyond drip line and no closer than 36 inches (900 mm) to tree trunk. Drill 2-inch- (50-mm-) diameter holes a minimum of 12 inches (300 mm) deep at 24 inches (600 mm) o.c. Backfill holes with an equal mix of augered soil and sand.

3.10 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove excess excavated material, displaced trees, trash, and debris and legally dispose of them off Owner's property.

END OF SECTION 015639

SECTION 017300 - EXECUTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:

1. Construction layout.
2. Field engineering and surveying.
3. Installation of the Work.
4. Cutting and patching.
5. Coordination of Owner-installed products.
6. Progress cleaning.
7. Starting and adjusting.
8. Protection of installed construction.
9. Correction of the Work.

B. Related Requirements:

1. Section 011000 "Summary" for limits on use of Project site.
2. Section 017700 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.

1.2 INFORMATIONAL SUBMITTALS

A. Certificates: Submit certificate signed by land surveyor or professional engineer certifying that location and elevation of improvements comply with requirements.

1.3 QUALITY ASSURANCE

A. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.

1. Structural Elements: When cutting and patching structural elements, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural element during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection

    a. Penetrations of end of remaining portion of the existing structure.

2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that result in increased maintenance or decreased operational life or safety.

3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in

reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety

4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

B. Conflicts within or among Contract Documents: If conflicts between Contract Documents are discovered, the CMR will, first, notify the Architect of the conflict and, second, assume that the higher quality choice is what is intended.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections.

B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning site work, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.

1. Before construction, verify the location and invert elevation at points of connection of sewage treatment facility, storm sewer, and water-service piping; underground electrical services, and other utilities.
2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.

B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.

3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

C. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Existing Utility Information: Furnish information to local utility that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Architect according to requirements in Section 013100 "Project Management and Coordination."

3.3 CONSTRUCTION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect promptly.

B. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Make the log available for reference by Architect.

3.4 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.

1. Make vertical work plumb and make horizontal work level.
2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Beneficial Occupancy.

D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.

F. Tools and Equipment: Do not use tools or equipment that produces harmful noise levels.

G. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.

1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
2. Allow for building movement, including thermal expansion and contraction.
3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, coordinate with the Architect to arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

J. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.5 CUTTING AND PATCHING

A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.

C. Temporary Support: Provide temporary support of work to be cut.

D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

E. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed relocated, or abandoned, bypass such services/systems before cutting to minimize interruption to occupied areas.

F. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
4. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
5. Proceed with patching after construction operations requiring cutting are complete.

G. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.
3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
4. Ceilings: Patch and repair in-place ceilings as necessary to provide an even-plane surface of uniform appearance.

H. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.6 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.

1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.

B. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.

1. Remove liquid spills promptly.

2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

C. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

D. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

E. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Beneficial Occupancy.

F. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Beneficial Occupancy.

G. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

H. Limiting Exposures: Supervise construction operations to assure that no part of the construction completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.7 STARTING AND ADJUSTING

A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.

C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.8 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Beneficial Occupancy.

B. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION 017300

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:

1. Beneficial Occupancy procedures.
2. Final completion procedures.
3. Warranties.
4. Final cleaning.
5. Repair of the Work.

B. Related Requirements:

1. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.

1.2 ACTION SUBMITTALS

A. Contractor's List of Incomplete Items: Initial submittal at Beneficial Occupancy.

B. Certified List of Incomplete Items: Final submittal at Final Completion.

1.3 CLOSEOUT SUBMITTALS

All of the following documents are available on the NC Office of State Construction Web Site: http://www.nc-sco.com/documents.aspx, under the heading “Project Closeout Forms”.

A. Certificates of Release: From authorities having jurisdiction.

B. Certificate of Insurance: For continuing coverage.

C. Project Approval Authorization; Partial Utilization (Beneficial Occupancy)

D. Project Approval Authorization; Final Inspection for Owner Occupancy.

E. Certificate of Compliance.

F. Certificate of Completion.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.

1.5 BENEFICIAL OCCUPANCY PROCEDURES

A. CMR's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.

B. Submittals Prior to Beneficial Occupancy: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Beneficial Occupancy. List items below that are incomplete at time of request.

1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, and similar final record information.
3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Architect. Label with manufacturer's name and model number where applicable.

    a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Owner’s signature for receipt of submittals.

5. Submit test/adjust/balance records, if required.
6. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.

C. Procedures Prior to Beneficial Occupancy: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Beneficial Occupancy. List items below that are incomplete at time of request.

1. Perform preventive maintenance on equipment used prior to Beneficial Occupancy.
2. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
3. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
4. Complete final cleaning requirements, including touchup painting.
5. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

D. Inspection: Submit a written request for inspection to determine Beneficial Occupancy a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Beneficial Occupancy after inspection or will notify CMR of items, either on CMR's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.

1. Re-inspection: Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for final completion.

1.6 FINAL COMPLETION PROCEDURES

A. Preliminary Procedures: Before requesting final inspection for determining Beneficial Occupancy, complete the following:

1. Submit a final Application for Payment according to Section 012900 "Payment Procedures."
2. Certified List of Incomplete Items: Submit certified copy of Architect's Beneficial Occupancy inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
4. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.

B. Inspection: Submit a written request for final inspection to determine acceptance. On receipt of request, Architect will either proceed with inspection or notify CMR of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Re-inspection: Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.7 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by CMR that are outside the limits of construction.

1. Organize items applying to each major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
2. Submit list of incomplete items in the following format:

    a. PDF, for review by Architect.
    b. Provide this list in a timely manner, and include the Designer review of these items as an item on the Project Schedule.

1.8 SUBMITTAL OF PROJECT WARRANTIES

A. Time of Submittal: All written warranties submitted to the Architect for designated portions of the Work shall commence on the date of Final Acceptance, or a later date when delay in submittal of warranties might limit Owner's rights under warranty.

B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.

1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch (215-by-280-mm) paper.
2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or

installation, including the name of the product and the name, address, and telephone number of Installer.

3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of CMR.
4. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.

C. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 FINAL CLEANING

A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Beneficial Occupancy for entire Project or for a designated portion of Project:

    a. Clean Project areas of rubbish, waste material, litter, and other foreign substances.
    b. Remove tools, construction equipment, machinery, and surplus material from Project area.
    c. Clean exposed hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Restore reflective surfaces to their original condition.
    d. Remove debris and surface dust from limited access spaces, plenums, and similar spaces.
    e. Sweep concrete floors broom clean in unoccupied spaces.
    f. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
    g. Remove labels that are not permanent.
    h. Wipe surfaces of mechanical and electrical equipment and similar equipment.
    i. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
    j. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
    k. Leave Project clean and ready for occupancy.

3.2 REPAIR OF THE WORK

A. Complete repair and restoration operations before requesting inspection for determination of Beneficial Occupancy.

B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.

1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that that already show evidence of repair or restoration.

    a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.

3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
4. Replace burned-out bulbs, bulbs noticeably dimmed or flickering, and defective and noisy starters in fluorescent fixtures to comply with requirements for new fixtures.

END OF SECTION 017700

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SECTION 017823 – OPERATION, MAINTENANCE, AND EMERGENCY SHUT OFF MANUALS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for preparing applicable operation, maintenance and emergency shut off manuals. This will be on loose leaf document that includes the following:

1. Directory of Vendors.
2. Operation manuals for systems, subsystems, and equipment.
3. Emergency shut off procedures for mechanical, electrical, and plumbing equipment and fixtures.

1.2 CLOSEOUT SUBMITTALS

A. Manual Content: Operations and maintenance manual content is specified in individual Specification Sections to be reviewed at the time of Section submittals.

1. Submit two paper copies and a PDF electronic file. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves.

B. Manual Submittal: Submit each manual in final form prior to requesting inspection for Beneficial Occupancy and at least 10 days before commencing demonstration and training. Note this on the Project Schedule.

PART 2 - PRODUCTS

2.1 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

A. The manual shall contain the following materials, in the order listed:

1. Title Page: Include the following information:

a. Subject matter included in manual.
b. Name and address of Project.
c. Name and address of Owner.
d. Date of submittal.
e. Name and contact information for CMR.
f. Name and contact information for Architect.
g. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.

2. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

3. Directory of Vendors.

a. Include names and contact information for subcontractors and vendors who installed the systems contained in the manuals.

4. Operation manuals for systems, subsystems, and equipment shall include:

a. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
b. Performance and design criteria if CMR is delegated design responsibility.
c. Operating standards.

d. Operating procedures.
e. Operating logs.
f. Wiring diagrams.
g. Control diagrams.
h. Piped system diagrams.
i. Precautions against improper use.
j. License requirements including inspection and renewal dates.

5. Emergency instructions will include shut off and re-start procedures for mechanical, electrical, and plumbing equipment and fixtures. Include locations of electrical panels, including main and sub panels, mechanical equipment controls and disconnects, and plumbing main and branch shut off valves (including connections to water main). The instructions shall cover procedures for the following types of emergencies:

a. Fire.
b. Flood.
c. Gas leak.
d. Water leak.
e. Power failure.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

A. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation. If applicable, provide the following information for specific equipment and systems:

1. Service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
2. Lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
3. Copies of maintenance agreements with name and telephone number of service agent.
4. Copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

B. Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes.

1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch (215-by-280-mm) paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

2. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

C. Manuals, Electronic Copy: Submit PDF version of Manuals on CD-ROM for the State, the NCDCNR, and the Aquarium.

END OF SECTION 017823

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for project record documents, including the following:

1. Record Drawings.
2. Record Specifications.
3. Record Product Data.

B. Related Requirements:

1. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.2 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:

1. Number of Copies: CMR submit one set of marked-up record prints; two CDRs.

B. Record Specifications: CMR submit one paper copy of Project's Specifications, including addenda and contract modifications; two CDRs.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

A. Record Prints: CMR maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised Drawings as modifications are issued. ***This set will be reviewed by the Architect at each Monthly Progress Meeting and must be kept current.***

1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

   a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
   b. Record data as soon as possible after obtaining it.
   c. Record and check the markup before enclosing concealed installations.

2. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.

3. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
4. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

2.2 RECORD SPECIFICATIONS

A. Preparation: CMR mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
4. Note related Change Orders and record Drawings where applicable.

B. Format: Submit record Specifications as paper copy.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

A. Recording: CMR maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.

B. CMR maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Architect's reference during normal working hours.

C. CMR submit Record Documents to the Architect for final review at the time of Beneficial Occupancy in the form of CDRs.

END OF SECTION 017839

SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:

1. Demonstration of operation of systems, subsystems, and equipment.
2. Training in operation and maintenance of systems, subsystems, and equipment.
3. Demonstration and training video recordings.

1.2 COORDINATION

A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.

B. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Architect.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:

1. Basis of System Design, Operational Requirements, and Criteria: Include the following:

    a. System, subsystem, and equipment descriptions.
    b. Performance and design criteria if Contractor is delegated design responsibility.
    c. Operating standards.
    d. Regulatory requirements.
    e. Equipment function.
    f. Operating characteristics.
    g. Limiting conditions.
    h. Performance curves.

2. Documentation: Review the following items in detail:

a. Emergency manuals.
b. Operations manuals.
c. Maintenance manuals.
d. Project record documents.
e. Identification systems.
f. Warranties and bonds.
g. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:

a. Instructions on meaning of warnings, trouble indications, and error messages.
b. Instructions on stopping.
c. Shutdown instructions for each type of emergency.
d. Operating instructions for conditions outside of normal operating limits.
e. Sequences for electric or electronic systems.
f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:

a. Startup procedures.
b. Equipment or system break-in procedures.
c. Routine and normal operating instructions.
d. Regulation and control procedures.
e. Control sequences.
f. Safety procedures.
g. Instructions on stopping.
h. Normal shutdown instructions.
i. Operating procedures for emergencies.
j. Operating procedures for system, subsystem, or equipment failure.
k. Seasonal and weekend operating instructions.
l. Required sequences for electric or electronic systems.
m. Special operating instructions and procedures.

5. Adjustments: Include the following:

a. Alignments.
b. Checking adjustments.
c. Noise and vibration adjustments.
d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:

a. Diagnostic instructions.
b. Test and inspection procedures.

7. Maintenance: Include the following:

a. Inspection procedures.
b. Types of cleaning agents to be used and methods of cleaning.
c. List of cleaning agents and methods of cleaning detrimental to product.
d. Procedures for routine cleaning
e. Procedures for preventive maintenance.
f. Procedures for routine maintenance.
g. Instruction on use of special tools.

8. Repairs: Include the following:

a. Diagnosis instructions.
b. Repair instructions.
c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
d. Instructions for identifying parts and components.
e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operation and Maintenance Data."

3.2 INSTRUCTION

A. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

1. Architect will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
2. Owner will furnish an instructor to describe Owner's operational philosophy.
3. Owner will furnish Contractor with names and positions of participants.

B. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

1. Schedule training with Owner with at least seven days' advance notice.

C. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

1

2

3 END OF SECTION 017900

SECTION 024119 - SELECTIVE STRUCTURE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Demolition and removal of selected portions of building or structure.
2. Demolition and removal of selected site elements.
3. Salvage of existing items to be reused or recycled.

B. Related Requirements:

1. Section 011000 "Summary" for restrictions on the use of the premises, Owner-occupancy requirements, and phasing requirements.
2. Section 017300 "Execution" for cutting and patching procedures.
3. Section 311000 "Site Clearing" for site clearing and removal of above- and below-grade improvements.
4. CMR's Abatement Report included with this Specification.

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner **ready for reuse**.

C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.4 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of CMR.

B. Door control hardware to be uninstalled and turned over to owner for all doors that are being removed.

C. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, Donor signage, Sculptures (including water features), commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.5 PREINSTALLATION MEETINGS

A. Predemolition Conference: Conduct conference at **Project site**.

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.

1.6 INFORMATIONAL SUBMITTALS

A. Proposed Protection Measures: Submit report, including drawings, that indicates the measures proposed for protecting individuals and property**, for environmental protection, for dust control and, for noise control**. Indicate proposed locations and construction of barriers.

B. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's adjacent on-site operations are uninterrupted.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of elevator and stairs.

C. Inventory: Submit a list of items to be removed and salvaged and deliver to Owner prior to start of demolition.

D. Predemolition Photographs or Video: Submit before Work begins.

E. Warranties: Documentation indicated that existing warranties are still in effect after completion of selective demolition.

1.7 CLOSEOUT SUBMITTALS

A. Inventory: Submit a list of items that have been removed and salvaged.

B. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.8 FIELD CONDITIONS

A. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical. The following items will be addressed in the prior project phase:

1. Before selective demolition, Owner will remove and address the following items:

a. AV Systems in Auditorium, Control Booth & Classrooms

b. Life Support systems

B. Items to be demolished as part of this Phase, as shown on Drawings AD-1.11 through AD-1.23 A include:

1. Structural Floor Slabs, Wood Decking, Interior Wall Partitions, Finished Flooring, Acoustic Ceiling Tiles, Light Fixtures, Casework, Plumbing Fixtures, Toilet Partitions, and Architectural Woodwork.

C. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire-protection facilities in service during selective demolition operations.

D. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

E. Hazardous material remediation is specified elsewhere in the Contract Documents.

F. A Report confirming the removal of hazardous materials must be issued prior to the commencement of Selective Demolition.

G. Equipment Sizes: Demolition and hauling equipment and other materials shall be of sizes that clear surfaces within existing spaces, areas, rooms, and openings, including temporary protection, by 12 inches (300 mm) or more.

H. Storage or sale of removed items or materials on-site is not permitted.

1.9 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties. Notify warrantor before proceeding. Existing warranties include the following:

1. Roofing.
2. Carpeting.

B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

PART 2 - PRODUCTS

2.1 PEFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review record documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in record documents.

C. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.

E. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

F. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

G. Survey of Existing Conditions: Record existing conditions by use of **measured drawings** and **preconstruction photographs**.

1. Comply with requirements specified in Section 013233 "Photographic Documentation."
2. Inventory and record the condition of items to be removed and salvaged. Provide **photographs or video** of conditions that might be misconstrued as damage caused by salvage operations.
3. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

1. Comply with requirements for existing services/systems interruptions specified in Section 011000 "Summary."

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. **Owner** will arrange to shut off indicated services/systems when requested by CMR.
2. Arrange to shut off indicated utilities with utility companies.
3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building, if needed.
4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated to be removed.

    a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
    b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
    c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
    d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
    e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
    f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
    g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.

C. Engineering Disciplines have separate drawings and specifications to cover the extent of their demolition work.

3.3 PREPARATION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Comply with requirements for access and protection specified in Section 015000 "Temporary Facilities and Controls."

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
4. Cover and protect furniture, furnishings, and equipment that have not been removed.
5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."

C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of selective demolition.

D. Remove temporary barricades and protections where hazards no longer exist.

3.4 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain **fire watch and** portable fire-suppression devices during flame-cutting operations and for at least 48 hours after the flame-cutting operations.
5. Maintain adequate ventilation when using cutting torches.
6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
9. Dispose of demolished items and materials promptly.
10. Remove and dispose of the fixed seating.

B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

C. Removed and Salvaged Items:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area **designated by Owner**.
5. Protect items from damage during transport and storage.

D. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition, **cleaned** and reinstalled in their original locations after selective demolition operations are complete.

3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch (19 mm) at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.

B. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, then remove concrete between saw cuts.

C. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.

D. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.

E. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings." Do not use methods requiring solvent-based adhesive strippers.

F. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weather tight. If needed, insert requirements for other materials, products, equipment, and services.

1. Remove existing roof membrane, flashings, copings, and roof accessories.
2. Remove existing roofing system down to substrate.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site **and legally dispose of them in an EPA-approved landfill**.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

B. Burning: Do not burn demolished materials.

C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.7 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

3.8 SELECTIVE DEMOLITION SCHEDULE

1. xxxx

B. Existing Items to Be Removed and Salvaged:

1. xxxx

C. Existing Items to Remain:

1. xxxx

END OF SECTION 024119

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Form-facing material for cast-in-place concrete.
2. Shoring, bracing, and anchoring.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at[Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each of the following:

1. Exposed surface form-facing material.
2. Concealed surface form-facing material.
3. Form ties.
4. Waterstops.
5. Form-release agent.

B. Shop Drawings: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.

1. For exposed vertical concrete walls, indicate dimensions and form tie locations.
2. Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with ACI 301.

    a. Location of construction joints is subject to approval of the Architect.

3. Indicate location of waterstops.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Minutes of preinstallation conference.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and

construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.

1. Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."
2. Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.

2.2 FORM-FACING MATERIALS

A. As-Cast Surface Form-Facing Material:

1. Provide continuous, true, and smooth concrete surfaces.
2. Furnish in largest practicable sizes to minimize number of joints.
3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete, and as follows:

    a. Plywood, metal, or other approved panel materials.
    b. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

        1) APA HDO (high-density overlay).
        2) APA MDO (medium-density overlay); mill-release agent treated and edge sealed.
        3) APA Structural 1 Plyform, B-B or better; mill oiled and edge sealed.
        4) APA Plyform Class I, B-B or better; mill oiled and edge sealed.

B. Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.

1. Provide lumber dressed on at least two edges and one side for tight fit.

2.3 WATERSTOPS

A. Flexible PVC Waterstops: U.S. Army Corps of Engineers CRD-C 572,with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints, with factory fabricate corners, intersections, and directional changes.
1. Profile: Ribbed with center bulb and Ribbed without center bulb.
2. Dimensions: 6 inches by 3/8 inch thick; nontapered.

B. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch (19 by 25 mm).

2.4 RELATED MATERIALS

A. Reglets: Fabricate reglets of not less than 0.022-inch- thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

B. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

D. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

E. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
2. Form release agent for form liners shall be acceptable to form liner manufacturer.

F. Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMWORK

A. Comply with ACI 301.

B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 (ACI 117M) and to comply with the Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete" for as-cast finishes.

C. Limit concrete surface irregularities as follows:

1. Surface Finish-1.0: ACI 117 Class D, 1 inch.
2. Surface Finish-2.0: ACI 117 Class B, 1/4 inch.
3. Surface Finish-3.0: ACI 117 Class A, 1/8 inch.

D. Construct forms tight enough to prevent loss of concrete mortar.

1. Minimize joints.
2. Exposed Concrete: Symmetrically align joints in forms.

E. Construct removable forms for easy removal without hammering or prying against concrete surfaces.

1. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.

2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
3. Install keyways, reglets, recesses, and other accessories, for easy removal.

F. Do not use rust-stained, steel, form-facing material.

G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.

1. Provide and secure units to support screed strips.
2. Use strike-off templates or compacting-type screeds.

H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.

1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
2. Locate temporary openings in forms at inconspicuous locations.

I. Chamfer exterior corners and edges of permanently exposed concrete.

J. At construction joints, overlap forms onto previously placed concrete not less than 12 inches (305 mm).

K. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.

1. Determine sizes and locations from trades providing such items.
2. Obtain written approval of Architect prior to forming openings not indicated on Drawings.

L. Construction and Movement Joints:

1. Construct joints true to line with faces perpendicular to surface plane of concrete.
2. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
3. Place joints perpendicular to main reinforcement.
4. Locate joints for beams, slabs, joists, and girders in the middle third of spans.

    a. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.

5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
6. Space vertical joints in walls as indicated on Drawings.

    a. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

M. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.

1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
2. Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.

N. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

O. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

P. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
4. Install dovetail anchor slots in concrete structures, as indicated on Drawings.
5. Clean embedded items immediately prior to concrete placement.

3.3 INSTALLATION OF WATERSTOPS

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm.

1. Install in longest lengths practicable.
2. Locate waterstops in center of joint unless otherwise indicated on Drawings.
3. Allow clearance between waterstop and reinforcing steel of not less than 2 times the largest concrete aggregate size specified in Section 033000 "Cast-In-Place Concrete."
4. Secure waterstops in correct position at 12 inches on center.
5. Field fabricate joints in accordance with manufacturer's instructions using heat welding.

    a. Miter corners, intersections, and directional changes in waterstops.
    b. Align center bulbs.

6. Clean waterstops immediately prior to placement of concrete.
7. Support and protect exposed waterstops during progress of the Work.

B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated on Drawings, according to manufacturer's written instructions, by adhesive bonding, mechanically fastening, and firmly pressing into place.

1. Install in longest lengths practicable.
2. Locate waterstops in center of joint unless otherwise indicated on Drawings.
3. Protect exposed waterstops during progress of the Work.

3.4 SHORING AND RESHORING INSTALLATION

A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.

1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.

C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare test reports.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

C. Inspections:

1. Inspect formwork for shape, location, and dimensions of the concrete member being formed.
2. Inspect insulating concrete forms for shape, location, and dimensions of the concrete member being formed.

END OF SECTION 031000

SECTION 032000 - CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel reinforcement bars.
2. Welded-wire reinforcement.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Each type of steel reinforcement.
2. Bar supports.
3. Mechanical splice couplers.

B. Shop Drawings: Comply with ACI SP-066:

1. Include placing drawings that detail fabrication, bending, and placement.
2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.

C. Construction Joint Layout: Indicate proposed construction joints required to build the structure.

1. Location of construction joints is subject to the approval of the Architect.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1. Reinforcement to Be Welded: Welding procedure specification in accordance with AWS D1.4/D1.4M

B. Material Test Reports: For the following, from a qualified testing agency:

1. Steel Reinforcement:

a. For reinforcement to be welded, mill test analysis for chemical composition and carbon equivalent of the steel in accordance with ASTM A706/A706M.

2. Mechanical splice couplers.

C. Field quality-control reports.

D. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.4/D 1.4M.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.

B. Low-Alloy Steel Reinforcing Bars: ASTM A706/A706M, deformed.

C. Headed-Steel Reinforcing Bars: ASTM A970/A970M.

D. Galvanized Reinforcing Bars:

1. Steel Bars: ASTM A615/A615M, Grade 60, deformed bars.
2. Zinc Coating: ASTM A767/A767M, Class II zinc coated after fabrication and bending.

E. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.

F. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.

G. Galvanized-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from galvanized-steel wire into flat sheets.

2.2 REINFORCEMENT ACCESSORIES

A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.

1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.
b. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

B. Mechanical Splice Couplers: ACI 318 Type 2, same material of reinforcing bar being spliced; tension-compression type, dowel-bar type or mechanical-lap type.

C. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch in diameter.

1. Finish: Plain and Galvanized.

2.3 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection of In-Place Conditions:

1. Do not cut or puncture vapor retarder.
2. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

3.2 INSTALLATION OF STEEL REINFORCEMENT

A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.

B. Accurately position, support, and secure reinforcement against displacement.

1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
2. Do not tack weld crossing reinforcing bars.

C. Preserve clearance between bars of not less than 1 inch, not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.

D. Provide concrete coverage in accordance with ACI 318.

E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

F. Splices: Lap splices as indicated on Drawings.

1. Bars indicated to be continuous, and all vertical bars shall be lapped not less than 36 bar diameters at splices, or 24 inches, whichever is greater.
2. Stagger splices in accordance with ACI 318.
3. Mechanical Splice Couplers: Install in accordance with manufacturer's instructions.
4. Weld reinforcing bars in accordance with AWS D1.4/D 1.4M, where indicated on Drawings.

G. Install welded-wire reinforcement in longest practicable lengths.

1. Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice."

a. For reinforcement less than W4.0 or D4.0, continuous support spacing shall not exceed 12 inches.

2. Lap edges and ends of adjoining sheets at least one wire spacing plus 2 inches for plain wire and 8 inches for deformed wire.
3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
4. Lace overlaps with wire.

3.3 JOINTS

A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement.
2. Continue reinforcement across construction joints unless otherwise indicated.
3. Do not continue reinforcement through sides of strip placements of floors and slabs.

3.4 INSTALLATION TOLERANCES

A. Comply with ACI 117.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare test reports.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

C. Inspections:

1. Steel-reinforcement placement.
2. Steel-reinforcement mechanical splice couplers.
3. Steel-reinforcement welding.

END OF SECTION 032000

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cast-in-place concrete, including concrete materials, mixture design, placement procedures, and finishes.

B. Related Requirements:

1. Section 031000 "Concrete Forming and Accessories" for form-facing materials, form liners, insulating concrete forms, and waterstops.
2. Section 032000 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, and other pozzolans materials subject to compliance with requirements.

B. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each of the following.

1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Aggregates.
5. Admixtures:
    a. Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.
6. Vapor retarders.
7. Liquid floor treatments.
8. Curing materials.
9. Joint fillers.

B. Design Mixtures: For each concrete mixture, include the following:

1. Mixture identification.
2. Minimum 28-day compressive strength.
3. Durability exposure class.
4. Maximum w/cm.
5. Calculated equilibrium unit weight, for lightweight concrete.
6. Slump limit.
7. Air content.
8. Nominal maximum aggregate size.
9. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
10. Intended placement method.
11. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Shop Drawings:

1. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

    a. Location of construction joints is subject to approval of the Architect.

D. Concrete Schedule: For each location of each Class of concrete indicated in "Concrete Mixtures" Article, including the following:

1. Concrete Class designation.
2. Location within Project.
3. Exposure Class designation.
4. Formed Surface Finish designation and final finish.
5. Final finish for floors.
6. Curing process.
7. Floor treatment if any.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Curing compounds.
4. Vapor retarders.
5. Joint-filler strips.

B. Material Test Reports: For the following, from a qualified testing agency:

1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Aggregates.
5. Admixtures:

C. Research Reports: For concrete admixtures in accordance with ICC's Acceptance Criteria AC198.

D. Preconstruction Test Reports: For each mix design.

E. Field quality-control reports.

F. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

A. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on each concrete mixture.

1. Include the following information in each test report:

a. Admixture dosage rates.
b. Slump.
c. Air content.
d. Seven-day compressive strength.
e. 28-day compressive strength.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with ASTM C94/C94M and ACI 301.

1.9 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 301 and ACI 306.1.

B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1.

PART 2 – PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

2.2 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand and source, throughout Project:

1. Portland Cement: ASTM C 150, Type II Supplement with the following:
    a. Fly Ash: ASTM C 618, Class C or F.
    b. Slag Cement: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33, Class 3 S coarse aggregate or better, graded. 3/4-inch (19-mm) nominal maximum coarse-aggregate size. Provide aggregates from single source.

1. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
2. Lightweight Aggregate: ASTM C 330, 1/2-inch (13-mm) nominal maximum aggregate size.

C. Water: ASTM C 94/C 94M and potable.

D. Air-Entraining Admixture: ASTM C 260. Concrete not exposed to weather does not require air-entrainment.

E. Crystalline-Forming Waterproofing Admixture: A powder admixture capable of producing concrete that is watertight under hydrostatic pressure up to seven atmospheres when tested in accordance with Corps of Engineers test CRD-C48 and capable of sealing cracks up to 0.4 mm.

1. Products: Subject to compliance with requirements, provide the following at dosage rates per manufacturer's recommendation.

    a. ICS/Penetron International/Ltd; Penetron Admix.
    b. Kryton International, Inc.; Krystol Internal Membrane (ESR-1515).
    c. Xypex Chemical Corporation; Xypex Admix C1000 or C500.
    d. Sika Corporation; Sika WT-215P
    e. BASF Corporation; MasterLife 300D
    f. The Euclid Chemical Company; Eucon Vandex AM-10

F. Waterproofing Additive: Integral waterproofing that can close concrete pores and inhibit reinforcement corrosion with no decrease in concrete strength or chemical resistance and reduce water absorption to less than 1%.

1. Potable Water Contact Approval: NSF certification for use on structures holding potable water, based on testing in accordance with NSF 61.
2. Manufacturers:

    a. Xypex Chemical Corporation: www.xypex.com.
    b. Penetron, Penetron Admix: www.penetron.com
    c. Sika USA, WT-240 P, usa.sika.com

G. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.3 VAPOR RETARDERS

A. Vapor barrier shall have all the following qualities:

1. Maintain permeance of less than 0.01 Perms [grains/(ft^2 · hr · inHg)] as tested in accordance with mandatory conditioning tests per ASTM E1745 Section 7.1 (7.1.1-7.1.5).
2. Other performance criteria:
    a. Strength: ASTM E1745 Class A.
    b. Thickness: 15 mils minimum
3. Provide third party documentation that all testing was performed on a single production roll per ASTM E1745 Section 8.1
4. Warranty: (a) compliance with the designated ASTM E1745 classification, and (b) no manufacturing defects in the product for, at least, the Life of the Building.

B. Vapor barrier products – provide the following or equivalent:

1. Basis of Design: Stego Wrap Vapor Barrier (15-mil) by Stego Industries LLC., (877) 464-7834 www.stegoindustries.com
2. Seams:
    a. Stego Tape by Stego Industries LLC, or equivalent.
3. Sealing Penetrations of Vapor barrier:
    a. Stego Mastic by Stego Industries LLC, or equivalent.
4. Stego Tape by Stego Industries LLC, or equivalent.
5. Perimeter/terminated edge seal:
    a. Stego Crete Claw (textured tape) by Stego Industries LLC, or equivalent.
    b. Stego Term Bar by Stego Industries LLC, or equivalent
    c. Stego Tack Tape (double-sided sealant tape) by Stego Industries LLC, (or equivalent. (One-sided seaming tape is not a recommended method of sealing at the terminated edge).
6. Penetration Prevention:
    a. Beast Foot by Stego Industries LLC, or equivalent.
    b. Beast Form Stake by Stego Industries LLC, or equivalent.
7. Vapor Barrier-Safe Hand Screed System
    a. Beast Screed by Stego Industries, LLC, or equivalent.

C. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, Size 57, with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

2.4 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, non-dissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

2.5 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

B. Abrasive Cast Aluminum Step Nosings:

1. Provide Cast Aluminum nosings for each concrete stair tread.
2. Nosings shall bee 4-inches deep by 8-inches less than the length of the tread and centered on the edge of the tread.
3. Abrasive shall bee #20 virgin grain Aluminum Oxide (AL203), integrally cast into the walking surface to a minimum depth of 1/32 inch.
4. Provide concealed anchors of the slotted rivet type.
5. Fasteners shall be 1/4" (6.35 mm) F.H.M. plated screws and nuts with steel wing anchors for fresh concrete are standard fasteners for nosings.
6. Cast aluminum shall be No. 43 prime and secondary ingot; low copper content.
7. Provide cross-hatched, fluted surface.
8. Nosings shall be “Alumogrit” Type 116A, as manufactured by Wooster Industries or equivalent product meeting the requirements of this specification

2.6 CONCRETE MIXTURES, GENERAL AND BUILDING ELEMENTS

A Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

B. Cementitious Materials: Use fly ash as needed to reduce the total amount of Portland cement, which would otherwise be used, by not less than 20 percent and not more than 30 percent.

C. Foundations: Proportion normal weight concrete mixture used for footings, grade beams, and tie beams as follows:

1. Exposure Class: ACI 318 F0, S1, W1, C2
2. Minimum Compressive Strength 4000 psi (20.7 Mpa) at 28 days.
3. Maximum Water-Cementitious Materials Ratio: 0.50.
4. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

D. Slabs-on-Grade: Proportion normal-weight concrete mixture for interior slabs-on-grade as follows:

1. Exposure Class: ACI 318 F0, S1, W0, C2
2. Minimum Compressive Strength 4500 psi at 28 days.
3. Maximum Water-Cementitious Materials Ratio: 0.50.
5. Do not air-entrain concrete to receive a hard trowel finish.
6. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Slabs on Metal Deck: Proportion structural lightweight concrete mixture for interior suspended slabs on metal deck as follows:

1. Exposure Class: ACI 318 F0, S0, W0, C0
2. Minimum Compressive Strength 3500 psi at 28 days.
3. Calculated Equilibrium Unit Weight: 110 lb/cu. ft. (1842 kg/cu. m, plus or minus 3 lb/cu. ft. (48.1 kg/cu. m) as determined by ASTM C 567.
4. Air Content: Do not allow air content of troweled finished floors to exceed 3 percent.
5. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.5 lb/cu. yd. (0.90 kg/cu. m).
6. Limit water-soluble, chloride-ion content in hardened concrete to 1.00 percent by weight of cement.

F. Tank Walls: Proportion normal weight concrete mixture used for tank walls as follows:

1. Exposure Class: ACI 318 F0, S1, W1, C2
2. Minimum Compressive Strength: 5000 psi at 28 days
3. Maximum w/cm: 0.5
4. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

G. Building Frame Members: Proportion normal-weight concrete used for columns, beams, and elevated slabs as follows:

1. Exposure Class: ACI 318 F0, S1, W1, C2
2. Minimum Compressive Strength: 5000 psi at 28 days
3. Maximum w/cm: 0.5
4. Air Content: Do not allow air content of troweled finished floors to exceed 3 percent.
5. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

H. Building Walls: Proportion normal-weight concrete used for building walls not part of tanks.

1. Exposure Class: ACI 318 F0, S1, W1, C2
2. Minimum Compressive Strength: 5000 psi at 28 days
3. Maximum w/cm: 0.5
4. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement

2.7 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116.

PART 3 - EXECUTION

3.1 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.
3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

3.2 INSTALLATION OF VAPOR RETARDER

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.

1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
2. Face laps away from exposed direction of concrete pour.
3. Lap vapor retarder over footings and grade beams not less than 6 inches, sealing vapor retarder to concrete.
4. Lap joints 6 inches and seal with manufacturer's recommended tape.
5. Terminate vapor retarder at the top of floor slabs, grade beams, and pile caps, sealing entire perimeter to floor slabs, grade beams, foundation walls, or pile caps.
6. Seal penetrations in accordance with vapor retarder manufacturer's instructions.
7. Protect vapor retarder during placement of reinforcement and concrete.

    a. Repair damaged areas by patching with vapor retarder material, overlapping damages area by 6 inches on all sides, and sealing to vapor retarder.

3.3 JOINTS

A. Construct joints true to line, with faces perpendicular to surface plane of concrete.

B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.

1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
2. Place joints perpendicular to main reinforcement.

    a. Continue reinforcement across construction joints unless otherwise indicated.
    b. Do not continue reinforcement through sides of strip placements of floors and slabs.

3. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
4. Locate joints for beams, slabs, joists, and girders at third points of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.

C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action does

not tear, abrade, or otherwise damage surface and before concrete develops random cracks.

D. Isolation Joints in Slabs-on-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.
2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface, where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

3.4 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.

1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.

B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, but not to exceed the amount indicated on the concrete delivery ticket.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.

1. If a section cannot be placed continuously, provide construction joints as indicated.
2. Deposit concrete to avoid segregation.
3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.

    a. Do not use vibrators to transport concrete inside forms.
    b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.
    c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
    d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Do not place concrete floors and slabs in a checkerboard sequence.
2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3. Maintain reinforcement in position on chairs during concrete placement.
4. Screed slab surfaces with a straightedge and strike off to correct elevations.
5. Level concrete, cut high areas, and fill low areas.
6. Slope surfaces uniformly to drains where required.
7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
8. Do not further disturb slab surfaces before starting finishing operations.

3.5 FINISHING FORMED SURFACES

A. As-Cast Surface Finishes:

1. ACI 301 Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.

    a. Patch voids larger than 1-1/2 inches wide or 1/2 inch deep.
    b. Remove projections larger than 1 inch.
    c. Tie holes do not require patching.
    d. Surface Tolerance: ACI 117 Class D.
    e. Apply to concrete surfaces not exposed to public view.

2. ACI 301 Surface Finish SF-3.0:

    a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
    b. Remove projections larger than 1/8 inch.
    c. Patch tie holes.
    d. Surface Tolerance: ACI 117 Class A.
    e. Locations: Apply to concrete surfaces exposed to public view, to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete.

B. Related Unformed Surfaces:

1. At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a color and texture matching adjacent formed surfaces.
2. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.6 FINISHING FLOORS AND SLABS

A. Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish:

1. While still plastic, texture concrete surface that has been screeded and bull-floated or darbied.
2. Use stiff brushes, brooms, or rakes to produce a profile depth of 1/4 inch in one direction.
3. Apply scratch finish to surfaces to receive concrete floor toppings or to receive mortar setting beds for bonded cementitious floor finishes.

C. Float Finish:

1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.
2. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture and complies with ACI 117 tolerances for conventional concrete.
3. Apply float finish to surfaces to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.

D. Trowel Finish:

1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
2. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance.
3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
4. Do not add water to concrete surface.
5. Do not apply hard-troweled finish to concrete, which has a total air content greater than 3 percent.
6. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thinset method. While concrete is still plastic, slightly scarify surface with a fine broom perpendicular to main traffic route.

1. Coordinate required final finish with Architect before application.
2. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.
2. Coordinate required final finish with Architect before application.

G. Slip-Resistive Finish: Before final floating, apply slip-resistive aggregate finish to concrete stair treads, platforms, ramps, and other rooms as indicated on drawings, reference A-9.1.

1. Apply in accordance with manufacturer's written instructions and as follows:

    a. Uniformly spread 25 lb/100 sq. ft. of dampened slip-resistive aggregate over surface in one or two applications.
    b. Tamp aggregate flush with surface, but do not force below surface.
    c. After broadcasting and tamping, apply float finish.
    d. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive aggregate.

3.7 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

A. Filling In:

1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
2. Mix, place, and cure concrete, as specified, to blend with in-place construction.
3. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases 6 inches high unless otherwise indicated on Drawings and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
3. Minimum Compressive Strength: 4000 psi at 28 days.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
6. Prior to pouring concrete, place and secure anchorage devices.

    a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    b. Cast anchor-bolt insert into bases.
    c. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items.

1. Cast-in inserts and accessories, as shown on Drawings.
2. Screed, tamp, and trowel finish concrete surfaces.

3.8 CONCRETE CURING

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

1. Comply with ACI 301 and ACI 306.1 for cold weather protection during curing.
2. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.
3. Maintain moisture loss no more than 0.2 lb/sq. ft. x h, calculated in accordance with ACI 305.1, before and during finishing operations.

B. Curing Formed Surfaces: Comply with ACI 308.1 as follows:

1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
3. If forms remain during curing period, moist cure after loosening forms.

4. If removing forms before end of curing period, continue curing for remainder of curing period, as follows:

a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
b. Continuous Sprinkling: Maintain concrete surface continuously wet.
c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.

1) Recoat areas subject to heavy rainfall within three hours after initial application.
2) Maintain continuity of coating and repair damage during curing period.

C. Curing Unformed Surfaces: Comply with ACI 308.1 as follows:

1. Begin curing immediately after finishing concrete.
2. Interior Concrete Floors:

a. Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:

1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.

a) Lap edges and ends of absorptive cover not less than 12-inches.
b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.

a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
b) Cure for not less than seven days.

3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:

a) Water.
b) Continuous water-fog spray.

b. Floors to Receive Penetrating Liquid Floor Treatments: Contractor has option of the following:

1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.

a) Lap edges and ends of absorptive cover not less than 12 inches.
b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.

a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
b) Cure for not less than seven days.

3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:

a) Water.
b) Continuous water-fog spray.

c. Floors to Receive Polished Finish: Contractor has option of the following:

1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.

a) Lap edges and ends of absorptive cover not less than 12 inches.
b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

2) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:

a) Water.
b) Continuous water-fog spray.

d. Floors to Receive Chemical Stain:

1) As soon as concrete has sufficient set to permit application without marring concrete surface, install curing paper over entire area of floor.
2) Install curing paper square to building lines, without wrinkles, and in a single length without end joints.
3) Butt sides of curing paper tight; do not overlap sides of curing paper.
4) Leave curing paper in place for duration of curing period, but not less than 28 days.

e. Floors to Receive Urethane Flooring:

1) As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.

2) Rewet absorptive cover and cover immediately with polyethylene moisture-retaining cover with edges lapped 6 inches and sealed in place.
3) Secure polyethylene moisture-retaining cover in place to prohibit air from circulating under polyethylene moisture-retaining cover.
4) Leave absorptive cover and polyethylene moisture-retaining cover in place for duration of curing period, but not less than 28 days.

f. Floors to Receive Curing Compound:

1) Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
2) Recoat areas subjected to heavy rainfall within three hours after initial application.
3) Maintain continuity of coating, and repair damage during curing period.
4) Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project.

g. Floors to Receive Curing and Sealing Compound:

1) Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.
2) Recoat areas subjected to heavy rainfall within three hours after initial application.
3) Repeat process 24 hours later, and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

3.9 TOLERANCES

A. Conform to ACI 117.

3.10 APPLICATION OF LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment in accordance with manufacturer's written instructions.

1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
2. Do not apply to concrete that is less than 14 days' old.
3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing.
4. Rinse with water; remove excess material until surface is dry.
5. Apply a second coat in a similar manner if surface is rough or porous.

3.11 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.

B. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

1. Testing agency shall be responsible for providing curing container for composite samples on Site and verifying that field-cured composite samples are cured in accordance with ASTM C31/C31M.
2. Testing agency shall immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
3. Testing agency shall report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.

    a. Test reports shall include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:

        1) Project name.
        2) Name of testing agency.
        3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
        4) Name of concrete manufacturer.
        5) Date and time of inspection, sampling, and field testing.
        6) Date and time of concrete placement.
        7) Location in Work of concrete represented by samples.
        8) Date and time sample was obtained.
        9) Truck and batch ticket numbers.
        10) Design compressive strength at 28 days.
        11) Concrete mixture designation, proportions, and materials.
        12) Field test results.
        13) Information on storage and curing of samples before testing, including curing method and maximum and minimum temperatures during initial curing period.
        14) Type of fracture and compressive break strengths at seven days and 28 days.

C. Batch Tickets: For each load delivered, submit three copies of batch delivery ticket to testing agency, indicating quantity, mix identification, admixtures, design strength, aggregate size, design air content, design slump at time of batching, and amount of water that can be added at Project site.

D. Inspections:

1. Headed bolts and studs.
2. Verification of use of required design mixture.
3. Concrete placement, including conveying and depositing.
4. Curing procedures and maintenance of curing temperature.
5. Verification of concrete strength before removal of shores and forms from beams and slabs.
6. Batch Plant Inspections: On a random basis, as determined by Architect.

E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M shall be performed in accordance with the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.

    a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C143/C143M:

   a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
   b. Perform additional tests when concrete consistency appears to change.

3. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete; ASTM C173/C173M volumetric method, for structural lightweight concrete.

   a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

4. Concrete Temperature: ASTM C1064/C1064M:

   a. One test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.

5. Unit Weight: ASTM C567/C567M fresh unit weight of structural lightweight concrete.

   a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

6. Compression Test Specimens: ASTM C31/C31M:

   a. Cast and laboratory cure two sets of two 6-inch by 12-inch or 4-inch by 8-inch cylinder specimens for each composite sample.
   b. Cast, initial cure, and field cure two sets of two standard cylinder specimens for each composite sample.

7. Compressive-Strength Tests: ASTM C39/C39M.

   a. Test one set of four laboratory-cured specimens at seven days and one set of two specimens at 28 days.
   b. Test one set of two field-cured specimens at seven days and one set of two specimens at 28 days.
   c. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

8. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
9. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi if specified compressive strength is 5000 psi, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi.
10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
11. Additional Tests:

a. Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.

1) Acceptance criteria for concrete strength shall be in accordance with ACI 301, section 1.6.6.3.

12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
13. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

F. Measure floor and slab flatness and levelness in accordance with ASTM E1155 within 48 hours of completion of floor finishing and promptly report test results to Architect.

3.12 CONCRETE SURFACE REPAIRS

A. Defective Concrete - Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval. In all cases cracks in slabs and exposed, formed surfaces are considered to be defects. Refer to ACI 224R for appropriate methods of crack repair.:

1. Repair and patch defective areas when approved by Architect.
2. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete.

a. Limit cut depth to 3/4 inch.
b. Make edges of cuts perpendicular to concrete surface.
c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
d. Fill and compact with patching mortar before bonding agent has dried.
e. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white Portland cement and standard Portland cement, so that, when dry, patching mortar matches surrounding color.

a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
b. Compact mortar in place and strike off slightly higher than surrounding surface.

3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces:

1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.

    a. Correct low and high areas.
    b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
3. After concrete has cured at least 14 days, correct high areas by grinding.
4. Correct localized low areas during, or immediately after, completing surface-finishing operations by cutting out low areas and replacing with patching mortar.

    a. Finish repaired areas to blend into adjacent concrete.

5. Correct other low areas scheduled to receive floor coverings with a repair underlayment.

    a. Prepare, mix, and apply repair underlayment and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
    b. Feather edges to match adjacent floor elevations.

6. Correct other low areas scheduled to remain exposed with repair topping.

    a. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations.
    b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

7. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete.

    a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a 3/4-inch clearance all around.
    b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
    c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
    d. Place, compact, and finish to blend with adjacent finished concrete.
    e. Cure in same manner as adjacent concrete.

8. Repair random cracks and single holes 1 inch or less in diameter with patching mortar.

    a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
    b. Dampen cleaned concrete surfaces and apply bonding agent.
    c. Place patching mortar before bonding agent has dried.
    d. Compact patching mortar and finish to match adjacent concrete.
    e. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.13 PROTECTION

A. Protect concrete surfaces as follows:

1. Protect from petroleum stains.
2. Diaper hydraulic equipment used over concrete surfaces.
3. Prohibit vehicles from interior concrete slabs.
4. Prohibit use of pipe-cutting machinery over concrete surfaces.
5. Prohibit placement of steel items on concrete surfaces.
6. Prohibit use of acids or acidic detergents over concrete surfaces.
7. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

Protect concrete surfaces scheduled to receive surface hardener or polished concrete finish using Floor Slab Protective Covering.

END OF SECTION 033000

SECTION 033300 - LANDSCAPE ARCHITECTURAL CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes cast-in-place architectural concrete, including form facings, reinforcement and accessories, concrete materials, concrete mixture design, placement procedures, and finishes.

1. Requirements in Section 033000 "Cast-in-Place Concrete" apply to landscape architectural concrete.
    a. Includes CIP site stairs
    b. Includes CIP site seat walls

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for concrete not designated as landscape architectural concrete.

1.3 DEFINITIONS

A. Cast-in-Place Architectural Concrete: Formed concrete that is exposed to view on surfaces of completed structure or building and that requires special concrete materials, formwork, placement, or finishes to obtain specified architectural appearance. Refer to drawings where Landscape Architectural Concrete scope is identified.

B. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

C. W/C Ratio: The ratio by weight of water to cementitious materials.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Require representatives of each entity directly concerned with cast-in-place architectural concrete to attend, including the following:

    a. Contractor's superintendent.
    b. Independent testing agency responsible for concrete design mixtures.
    c. Ready-mix concrete manufacturer.
    d. Cast-in-place architectural concrete Subcontractor.

2. Review concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction joints, forms and form-removal limitations, reinforcement accessory installation, concrete repair procedures, and protection of cast-in-place architectural concrete.
3. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. DO NOT add water to concrete during delivery, at Project site, or during placement unless approved by Architect.

C. Formwork Shop Drawings: Show formwork construction, including form-facing joints, rustications, construction and contraction joints, form joint-sealant details, form tie locations and patterns, inserts and embedments, cutouts, cleanout panels, and other items that visually affect cast-in-place architectural concrete.

D. Placement Schedule: Submit concrete placement schedule before start of placement operations. Include locations of all joints, including construction joints.

E. Samples: For each of the following materials:

1. Form-facing panels.
2. Form ties.
3. Form liners.
4. Exposed aggregates.
5. Coarse- and fine-aggregate gradations.
6. Chamfers and rustications.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Repair materials.

C. Material Test Reports: For the following, by a qualified testing agency:

1. Aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "NRMCA Quality Control Manual - Section 3, Certification of Ready Mixed Concrete Production Facilities."

B. Mockups: Before casting architectural concrete, build mockups to verify selections made under Sample submittals and to demonstrate typical joints, surface finish, texture, tolerances, and standard of workmanship. Build mockups to comply

C. with the following requirements, using materials indicated for the completed Work:

1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
2. Build mockups of typical exterior wall of cast-in-place architectural concrete as shown on Drawings. Refer to drawings for size of mockup requirements.
3. Demonstrate curing, cleaning, and protecting of cast-in-place architectural concrete, finishes, and contraction joints, as applicable.
4. In presence of Architect, damage part of the exposed-face surface for each finish, color, and texture, and demonstrate materials and techniques proposed for repair of tie holes and surface blemishes to match adjacent undamaged surfaces.
5. Obtain Architect's approval of mockups before casting architectural concrete.
6. ***Approved mockups may NOT become part of the completed Work.***

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on concrete mixtures.

1.9 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents.
4. Do not use chemical accelerators unless otherwise specified and approved in design mixtures.

B. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301.
2. ACI 303.1.

2.2 FORM-FACING MATERIALS

A. General: Comply with Section 033000 "Cast-in-Place Concrete" for formwork and other form-facing material requirements.

B. Source Limitations: Obtain each type form-facing material from single source from single manufacturer.

Form Liners: Units of face design, texture, arrangement, and configuration indicated. Furnish with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent surface treatments of concrete. Refer to drawings for indication of which finish (Type 'A' applies to site walls and site seat walls on Landscape (L Series) drawings. site walls and site cast-in-place concrete elements. Form liner types/ requirements for Type 'A' are identified below.

Form Liner Types:

1. Architectural Grade Form-Liner Finish (Type 'A' Finish Quality):

a. Available manufacturers include but are not limited to the following:
- **1) Richmond International**
- **2) Performance Panels**
- **3) Paneltech**

b. Basis of Design:
- **1) Manufacturer: Richmond International**
- **2) Model: Richform Titanium**
- **3) Material: Phenolic Film Faced Plyform, HDO Concrete Form/ Certified Film Face**
- **4) Ply Dimension: ¾" Ply thickness**
- **5) Grade: A/A**
- **6) Phenolic Type: 240g/m2**
- **7) Edge Sealed: Waterproof paint**
- **8) Tolerance: (+/-) 0.3 mm**

C. Rustication Strips: Metal or rigid plastic, or with sides beveled and back kerfed; nonstaining; in longest practicable lengths.

D. Chamfer Strips: Metal, rigid plastic, elastomeric rubber, or dressed wood, dimensions per details; nonstaining; in longest practicable lengths.

E. Form Joint Tape: Compressible foam tape; pressure sensitive; AAMA 800; minimum 1/4 inch thick.

F. Form Joint Sealant: Elastomeric sealant complying with ASTM C 920, Type M or Type S, Grade NS, that adheres to form joint substrates.

1. Silicone type sealants and other sealants with history of potential staining/ streaking are not allowed.

G. Form-Release Agent: Commercially formulated, colorless form-release agent that will not bond with, stain, or adversely affect architectural concrete surfaces and will not impair subsequent treatments of those surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

H. Form Ties: Factory-fabricated, internally disconnecting ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
1. Furnish internally disconnecting ties that will leave no metal closer than 1-1/2 inches, from the architectural concrete surface.

2.3 STEEL REINFORCEMENT AND ACCESSORIES

A. General: Comply with Section 033000 "Cast-in-Place Concrete" for steel reinforcement and other requirements for reinforcement accessories.

B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire fabric in place; manufactured according to CRSI's "Manual of Standard Practice."

1. Where legs of wire bar supports contact forms, use CRSI Class 1, gray, plastic-protected bar supports.

2.4 CONCRETE MATERIALS

A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

B. Cementitious Materials:

1. Portland Cement: ASTM C 150/C 150M, Type I , gray.
2. Fly Ash: ASTM C 618, Class F.
3. Slag Cement: ASTM C 989/C 989M, Grade 100 or Grade 120.
4. Silica Fume: ASTM C 1240 amorphous silica.

C. Normal-Weight Aggregates: ASTM C 33/C 33M, Class 5S coarse aggregate or better, graded. Provide aggregates from single source with documented service-record data of at least 10

years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 1/2 inch.
2. Gradation: Uniformly graded.

D. Normal-Weight Fine Aggregate: ASTM C 33/C 33M, manufactured or natural sand, from same source for entire Project.

E. Air-Entraining Admixture: ASTM C 260/C 260M.

F. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that does not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.

2. Retarding Admixture: ASTM C 494/C 494M, Type B.

3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.

4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.

5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

G. Water: Potable, complying with ASTM C 94/C 94M, except free of wash water from mixer washout operations.

2.5 CURING MATERIALS

A. Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

2.6 REPAIR MATERIALS

A. Bonding Agent: ASTM C 1059/C 1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

B. Epoxy Bonding Adhesive: ASTM C 881/C 881M two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements.
1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.7 CONCRETE MIXTURES

A. Obtain each color, size, type, and variety of concrete mixture from single manufacturer with resources to provide cast-in-place architectural concrete of consistent quality in appearance and physical properties.

B. Prepare design mixtures for each type and strength of cast-in-place architectural concrete proportioned on basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified independent testing agency for preparing and reporting proposed design mixtures based on laboratory trial mixtures.

C. Cementitious Materials: For cast-in-place architectural concrete exposed to deicers, limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements. Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Admixtures: Use admixtures according to manufacturer's written instructions.

F. Concrete Mixtures:

1. Compressive Strength (28 Days): 5000 psi.
2. Maximum W/C Ratio: 0.46.
3. Slump Limit: 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture plus or minus 1 inch.
4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery.

2.8 CONCRETE MIXING

A. Ready-Mixed Architectural Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and furnish batch ticket information.

1. Clean equipment used to mix and deliver cast-in-place architectural concrete to prevent contamination from other concrete.
2. When air temperature is between 85 and 90 deg F reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F , reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION

A. General: Comply with Section 033000 "Cast-in-Place Concrete" for formwork, embedded items, and shoring and reshoring.

B. In addition to ACI 303.1 limits on form-facing panel deflection, limit cast-in-place architectural concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:

1. Class A, 1/8 inch.

C. Construct forms to result in cast-in-place architectural concrete that complies with ACI 117 (ASI 117M).

D. Construct forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-in-place surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood rustications, keyways, reglets, recesses, and the like, for easy removal.

1. Seal form joints and penetrations at form ties with form joint tape or form joint sealant to prevent cement paste leakage.
2. Do not use rust-stained steel form-facing material.

E. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

F. Do not chamfer exterior corners and edges of cast-in-place architectural concrete unless indicated on drawing details.

G. Coat contact surfaces of wood rustications and chamfer strips with sealer before placing reinforcement, anchoring devices, and embedded items.

H. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

I. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

J. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

K. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

L. Place form liners accurately to provide finished surface texture indicated. Provide solid backing and attach securely to prevent deflection and maintain stability of liners during concreting. Prevent form liners from sagging and stretching in hot weather. Seal joints of form liners and form-liner accessories to prevent mortar leaks. Coat form liner with form-release agent.

3.2 REINFORCEMENT AND INSERT INSTALLATION

A. General: Comply with Section 033000 "Cast-in-Place Concrete" for fabricating and installing steel reinforcement. Securely fasten steel reinforcement and wire ties against shifting during concrete placement.

B. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

3.3 REMOVING AND REUSING FORMS

A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.

1. Schedule form removal to maintain surface appearance that matches approved mockups.

B. Clean and repair surfaces of forms to be reused in the Work. Do not use split, frayed, delaminated, or otherwise damaged form-facing material. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for cast-in-place architectural concrete surfaces.

3.4 JOINTS

A. Construction Joints: Install construction joints true to line, with faces perpendicular to surface plane of cast-in-place architectural concrete, so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated.
2. Form keyed joints as indicated. Align construction joint within rustications attached to form-facing material.
3. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

B. Contraction Joints: Form weakened-plane contraction joints true to line, with faces perpendicular to surface plane of cast-in-place architectural concrete, so

C. strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

3.5 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, form-release agent, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.

C. Deposit concrete continuously between construction joints. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 303.1.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. Do not permit vibrators to contact forms.

3.6 FINISHES, GENERAL

A. Architectural Concrete Finish: Match Architect's design reference sample, identified and described as indicated, to satisfaction of Architect.

B. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces.

1. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

C. Maintain uniformity of special finishes over construction joints unless otherwise indicated.

3.7 AS-CAST FORMED FINISHES

A. Architectural Grade Form-Liner Finish (Type 'A' Finish Quality): Produce a smooth, textured surface free of pockets, streaks, and honeycombs, and of uniform appearance, color, and texture by use of a lined high density overlay form material.

3.8 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with ACI 301 for hot-weather protection during curing.

B. Begin curing cast-in-place architectural concrete immediately after removing forms from concrete. Cure according to ACI 308.1, by one or a combination of the following methods that will not mottle, discolor, or stain concrete:

1. Curing Compound: Mist concrete surfaces with water. Apply curing compound uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.9 FIELD QUALITY CONTROL

A. General: Comply with field quality-control requirements in Section 033000 "Cast-in-Place Concrete."

B. In Progress - As Built Survey

1. Contractor is to provide an as-built survey by a licensed engineer for construction of the cast-in-place concrete seatwalls in entry plaza. This does not supercede any requirements for State Construction Office or University closeout / final approval procedures.

3.10 REPAIR, PROTECTION, AND CLEANING

A. Repair and cure damaged finished surfaces of cast-in-place architectural concrete when approved by Architect. Match repairs to color, texture, and uniformity of surrounding surfaces and to repairs on approved mockups.

1. Remove and replace cast-in-place architectural concrete that cannot be repaired and cured to Architect's approval.

B. Protect corners, edges, and surfaces of cast-in-place architectural concrete from damage; use guards and barricades.

C. Protect cast-in-place architectural concrete from staining, laitance, and contamination during remainder of construction period.

D. Clean cast-in-place architectural concrete surfaces after finish treatment to remove stains, markings, dust, and debris.

E. Wash and rinse surfaces according to concrete finish applicator's written instructions. Protect other Work from staining or damage due to cleaning operations.

1. Do not use cleaning materials or processes that could change the appearance of cast-in-place architectural concrete finishes.

END OF SECTION 033300

SECTION 042000 - UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete masonry units (CMU's).
2. Concrete building brick.

B. Related Sections:

1. 055000, Metal Fabrications.
2. 084113, Aluminum-Framed Entrances and Storefronts.
3. 092900, Gypsum Board.
4. 093000, Tiling
5. 099123, Interior Painting.
6. 100000, Miscellaneous Specialties.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For reinforcing steel. Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement."

C. Samples for Verification: For each type and color of exposed masonry unit.

1.3 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each type and size of product indicated. For masonry units include material test reports substantiating compliance with requirements.

B. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

1.4 QUALITY ASSURANCE

A. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

1 1.5 PROJECT CONDITIONS

2 A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice
3 or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost
4 or by freezing conditions. Comply with cold-weather construction requirements contained in
5 ACI 530.1/ASCE 6/TMS 602.

6 B. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in
7 ACI 530.1/ASCE 6/TMS 602.

8 PART 2 - PRODUCTS

9 2.1 MASONRY UNITS, GENERAL

10 A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to
11 contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units
12 where such defects will be exposed in the completed Work.

13 B. Fire-Resistance Ratings: Where indicated, provide units that comply with requirements for fire-
14 resistance ratings indicated as determined by testing according to ASTM E 119, by equivalent
15 masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

16 2.2 CONCRETE MASONRY UNITS

17 A. Shapes: Provide shapes indicated and for lintels, corners, jambs, sashes, movement joints,
18 headers, bonding, and other special conditions.

19 B. CMUs: ASTM C 90.

20 1. Unit Compressive Strength: Provide units with minimum average net-area compressive
21 strength of 2800 psi.
22 2. Density Classification: Lightweight unless otherwise indicated.

23 C. Concrete Building Brick: ASTM C 55.

24 1. Unit Compressive Strength: Provide units with minimum average net-area compressive
25 strength of 2800 psi.
26 2. Density Classification: Lightweight.

27 2.3 MASONRY LINTELS

28 A. General: Provide one of the following:

29 B. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs
30 with reinforcing bars placed as indicated and filled with coarse grout.

31 2.4 MORTAR AND GROUT MATERIALS

32 A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather
33 construction. Provide natural color.

34 B. Hydrated Lime: ASTM C 207, Type S.

35 C. Masonry Cement: ASTM C 91.

D. Aggregate for Mortar: ASTM C 144.

1. For joints less than 1/4 inch (6 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.

E. Aggregate for Grout: ASTM C 404.

F. Cold-Weather Admixture: Non-chloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

G. Water: Potable.

2.5 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60 (Grade 420).

B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.

1. Interior Walls: Hot-dip galvanized, carbon steel.
2. Exterior Walls: Hot-dip galvanized, carbon steel.
3. Wire Size for Side Rods: 0.187-inch (4.76-mm) diameter.
4. Wire Size for Cross Rods: 0.187-inch (4.76-mm) diameter.
5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches (407 mm) o.c.
6. Provide in lengths of not less than 10 feet (3 m), with prefabricated corner and tee units.

C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

D. Masonry Joint Reinforcement for Multiwythe Masonry:

1. Ladder type with 1 side rod at each face shell of hollow masonry units more than 4 inches (100 mm) wide, plus 1 side rod at each wythe of masonry 4 inches (100 mm) wide or less.

2.6 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.

1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 153/A 153M, Class B-2 coating.
2. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.
3. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- (6.35-mm-) diameter, hot-dip galvanized steel wire.
2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch (25 mm) of masonry face, made from 0.25-inch- (6.35-mm-) diameter, hot-dip galvanized steel wire.

C. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.105-inch-thick steel sheet, galvanized after fabrication
2. Tie Section: Triangular-shaped wire tie made from 0.187-inch-diameter, hot-dip galvanized-steel wire.

D. Partition Top Anchors: 0.105-inch-thick metal plate with a 3/8-inch-diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.

E. Rigid Anchors: Fabricate from steel bars 1-1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches or with cross pins unless otherwise indicated.

1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A153/A153M.

F. Anchor Bolts: Headed or L-shaped steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C.

2.7 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Pre-molded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; formulated from neoprene, urethane, or PVC.

B. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

2.8 FOAM-PLASTIC BOARD INSULATION

A. Extruded-Polystyrene Board Insulation: ASTM C 578, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84. Refer to Section 072100.

2.9 MASONRY CLEANERS

A. Use detergent expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

2.10 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use portland cement-lime mortar unless otherwise indicated.
3. For exterior masonry, use portland cement-lime mortar.
4. For reinforced masonry, use portland cement-lime mortar.

B. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated.

1. For masonry below grade or in contact with earth, use Type S.
2. For reinforced masonry, use Type S.
3. For exterior and interior, above-grade, load-bearing walls use Type S.

C. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

B. Select and arrange units for exposed unit masonry to produce a uniform blend of textures.

3.2 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch (12 mm) or minus 1/4 inch (6 mm).
2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch (12 mm).
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch (6 mm) in a story height or 1/2 inch (12 mm) total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2 inch (12 mm) maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch (12 mm) maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch (12 mm) maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm), with a maximum thickness limited to 1/2 inch (12 mm).
2. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch (9 mm) or minus 1/4 inch (6 mm).
3. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm).

3.3 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.

C. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

D. Fill cores in hollow CMUs with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

3.4 MORTAR BEDDING AND JOINTING

A. Lay CMUs as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

3.5 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (150 mm).

1. Space reinforcement not more than 16 inches (406 mm) o.c.
2. Space reinforcement not more than 8 inches (203 mm) o.c. in foundation walls and parapet walls.
3. Provide reinforcement not more than 8 inches (203 mm) above and below wall openings and extending 12 inches (305 mm) beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

3.6 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:

1. Provide an open space not less than 1 inch (25 mm) wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches (610 mm) o.c. vertically and 36 inches (915 mm) o.c. horizontally.

3.7 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 60 inches (1520 mm).

3.8 PROTECTION, REPAIRING, POINTING, AND CLEANING

A. Prior to the application of wall coatings, protect exposed wall corners with corrugated cardboard, extending a minimum of three inches on each side of the corner.

B. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

3.9 MASONRY WASTE DISPOSAL

A. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Do not dispose of masonry waste as fill within 18 inches (450 mm) of finished grade.

B. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042000

SECTION 051200 - STRUCTURAL STEEL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural steel.
2. Shear stud connectors.
3. Shrinkage-resistant grout.

1.2 DEFINITIONS

A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/AISC 303.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Structural-steel materials.
2. High-strength, bolt-nut-washer assemblies.
3. Shear stud connectors.
4. Anchor rods.
5. Threaded rods.
6. Shop primer.
7. Galvanized-steel primer.
8. Galvanized repair paint.
9. Shrinkage-resistant grout.

B. Shop Drawings: Show fabrication of structural-steel components.

C. Delegated-Design Submittal: For structural-steel connections indicated on Drawings to comply with design loads, include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Mill test reports for structural-steel materials, including chemical and physical properties.

C. Source quality-control reports.

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category BU or is accredited by the IAS Fabricator Inspection Program for Structural Steel (Acceptance Criteria 172).

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with applicable provisions of the following specifications and documents:

1. ANSI/AISC 303.
2. ANSI/AISC 360.
3. RCSC's "Specification for Structural Joints Using High-Strength Bolts."

B. Connection Design Information:

1. Option 3 and 3B: Design connections and final configuration of member reinforcement at connections in accordance with ANSI/AISC 303 by fabricator's qualified professional engineer.

    a. Use Load and Resistance Factor Design; data are given at factored-load level.

C. Moment Connections: Type FR, fully restrained.

D. Construction: As indicated.

2.2 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A992/A992M.

B. Channels, Angles, M-Shapes, S-Shapes: ASTM A36/A36M.

C. Plate and Bar: ASTM A36/A36M.

D. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade C structural tubing.

E. Steel Pipe: ASTM A53/A53M, Type E or Type S, Grade B.

F. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS AND CONNECTORS

A. High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325 (Grade A325M), Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH (ASTM A563M,

Class 10S), heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.

1. Direct-Tension Indicators: ASTM F959/F959M, Type 325-1 (Type 8.8-1), compressible-washer type with plain finish.

B. Zinc-Coated High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325 (Grade A325M), Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH (ASTM A563M, Class 10S), heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

1. Finish: Hot-dip zinc coating.
2. Direct-Tension Indicators: ASTM F959/F959M, Type 325-1 (Type 8.8-1), compressible-washer type with mechanically deposited zinc coating finish.

C. Shear Stud Connectors: ASTM A108, AISI C-1015 through C-1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

2.4 RODS

A. Unheaded Anchor Rods: ASTM F1554, Grade 36.

1. Configuration: Straight.
2. Finish: Plain or Hot-dip zinc coating, ASTM A153/A153M, Class C.

B. Headed Anchor Rods: ASTM F1554, Grade 36, straight.

1. Finish: Plain or Hot-dip zinc coating, ASTM A153/A153M, Class C.

C. Threaded Rods: ASTM A36/A36M.

1. Finish: Plain or Hot-dip zinc coating, ASTM A153/A153M, Class C.

2.5 PRIMER

A. Steel Primer:

1. Comply with Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
2. SSPC-Paint 23, latex primer.
3. Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

B. Galvanized-Steel Primer:

1. Etching Cleaner: MPI#25, for galvanized steel.
2. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20.

2.6 SHRINKAGE-RESISTANT GROUT

A. Metallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.

B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.7 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.

B. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using automatic end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.

2.8 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

2.9 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel in accordance with ASTM A123/A123M.

1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.

2.10 SHOP PRIMING

A. Shop prime steel surfaces, except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
2. Surfaces to be field welded.
3. Surfaces of high-strength bolted, slip-critical connections.
4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
5. Galvanized surfaces unless indicated to be painted.
6. Surfaces enclosed in interior construction.

B. Surface Preparation of Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces in accordance with the following specifications and standards:

1. SSPC-SP 2.
2. SSPC-SP 3.
3. SSPC-SP 7 (WAB)/NACE WAB-4.

4. SSPC-SP 6 (WAB)/NACE WAB-3.

C. Surface Preparation of Galvanized Steel: Prepare galvanized-steel surfaces for shop priming by thoroughly cleaning steel of grease, dirt, oil, flux, and other foreign matter, and treating with etching cleaner or in accordance with SSPC-SP 16.

D. Priming: Immediately after surface preparation, apply primer in accordance with manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

2.11 SOURCE QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform shop tests and inspections.

1. Allow testing agency access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
2. Bolted Connections: Inspect shop-bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
3. Welded Connections: Visually inspect shop-welded connections in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

    a. Liquid Penetrant Inspection: ASTM E165/E165M.
    b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
    c. Ultrasonic Inspection: ASTM E164.
    d. Radiographic Inspection: ASTM E94/E94M.

4. In addition to visual inspection, test and inspect shop-welded shear stud connectors in accordance with requirements in AWS D1.1/D1.1M.
5. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and in accordance with ANSI/AISC 303 and ANSI/AISC 360.

B. Baseplates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate.
3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Promptly pack shrinkage-resistant grout solidly between bearing surfaces and plates, so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for grouting.

C. Maintain erection tolerances of structural steel within ANSI/AISC 303.

3.3 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt and joint type specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with ANSI/AISC 303 and ANSI/AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform the following special inspections:

1. Verify structural-steel materials and inspect steel frame joint details.
2. Verify weld materials and inspect welds.
3. Verify connection materials and inspect high-strength bolted connections.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

1. Bolted Connections: Inspect bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
2. Welded Connections: Visually inspect field welds in accordance with AWS D1.1/D1.1M.

a. In addition to visual inspection, test and inspect field welds in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

1) Liquid Penetrant Inspection: ASTM E165/E165M.
2) Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
3) Ultrasonic Inspection: ASTM E164.
4) Radiographic Inspection: ASTM E94/E94M.

END OF SECTION 051200

SECTION 052100 - STEEL JOISTS

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. K-series steel Joists
2. Steel joist accessories

1.2 SUBMITTALS

A. Product Data: For each type of joists, accessory, and product indicated.

B. Shop Drawings:

C. Product certificates.

D. Welding certificates.

E. Research/evaluation reports.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables in SJI's "Specifications."

1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.

B. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel,".

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Consolidated

2.3 STEEL JOISTS

A. K-Series Steel Joist: Manufactured steel joists of type indicated according to "Standard Specification for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.

2.4 STEEL JOIST ACCESSORIES

C. Bridging:

1. Provide bridging anchors and number of rows of horizontal or diagonal bridging of material, size, and type required by SJI's "Specifications" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.
2. Schematically indicated. Detail and fabricate according to SJI's "Specifications." Furnish additional erection bridging if required for stability.
3. Fabricate as indicated on Drawings and according to SJI's "Specifications. Furnish additional erection bridging if required for stability.

D. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325 (Grade A325M), Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, (ASTM A563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

1. Finish: Plain or Hot-dip zinc coating, ASTM A153/A153M, Class C.

E. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.

CLEANING AND SHOP PAINTING

F. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories.

G. Apply one coat of shop primer to joists and joist accessories.

H. Shop priming of joists and joist accessories is specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

PART 2 - EXECUTION

2.1 INSTALLATION

A. Do not install joists until supporting construction is in place and secured.

B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written instructions, and requirements in this Section.

1. Before installation, splice joists delivered to Project site in more than one piece.
2. Space, adjust, and align joists accurately in location before permanently fastening.
3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.

C. Field weld joists to supporting steel bearing plates and framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

D. Bolt joists to supporting steel framework using carbon-steel bolts.

E. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

2.2 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Visually inspect field welds according to AWS D1.1/D1.1M.

C. Visually inspect bolted connections.

D. Prepare test and inspection reports.

END OF SECTION 052100

SECTION 053100 - STEEL DECK

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes the following:

1.2 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," and AWS D1.3, "Structural Welding Code--Sheet Steel."

B. Fire-Test-Response Characteristics: Where indicated, provide steel deck units identical to those steel deck units tested for fire resistance per ASTM E 119 by a testing and inspection agency acceptable to authorities having jurisdiction.

1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
2. Steel deck units shall be identified with appropriate markings of applicable testing and inspecting agency.

C. AISI Specifications: Calculate structural characteristics of steel deck according to AISI's "Specification for the Design of Cold-Formed Steel Structural Members."

PART 2 – PRODUCTS

2.1 COMPOSITE FLOOR DECK

A. Composite Steel Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with “SDI Specifications and Commentary for Composite Steel Floor Deck,” in SDI Publication No. 31, with the minimum section properties indicated, and with the following:

1. Galvanized Steel Sheet: ASTM A 653/ A 653M, Structural Steel (SS), Grade 33 (230), G90 zinc coating.
2. Profile Depth: As indicated on structural drawings.
3. Design Uncoated-Steel Thickness: As indicated on structural drawings.

2.2 ROOF DECK

A. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:

1. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33, G60 zinc coating.
2. Deck Profile: As indicated.

3. Profile Depth: As indicated.
4. Design Uncoated-Steel Thickness: As indicated.
5. Span Condition: As indicated.
6. Side Laps: Overlapped or interlocking seam at Contractor's option.

2.4 ACCESSORIES

A. Accessories: Steel deck manufacturer's standard accessory materials, including mechanical fasteners, closure strips, pour stops, and closures for deck.

B. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035, with dry film containing a minimum of 94 percent zinc dust by weight.

C. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

D. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 (4.8-mm) minimum diameter.

E. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

F. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

B. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

C. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

D. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

E. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

F. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

G. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.

1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.

H. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.

I. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

3.2 REPAIR

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

1 END OF SECTION 053100

SECTION 054000 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Exterior non-load-bearing wall framing.
2. Exterior ceiling joist, soffit and fascia framing.
3. Interior suspended overhead framing including ceilings, ceiling clouds, bulkheads and soffits.
4. All framing designated as “CFSF-S” on drawings.

B. Related Sections include the following:

1. Division 1 Section “Special Inspection Services” for administrative and procedural requirements for special inspection services.
2. Section 033000 Cast-in-Place Concrete.
3. Section 042000 Unit Masonry.
4. Section 061053 Miscellaneous Rough Carpentry.
5. Section 061600 Sheathing.
6. Section 064023 Interior Architectural Woodwork, for support blocking.
7. Section 072100 Insulation.
8. Section 079200 Joint Sealants.
9. Section 092216 Non-Structural Metal Framing
10. Section 092900 Gypsum Board.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide cold-formed metal framing capable of withstanding design loads within limits and under conditions indicated.

1. Design Loads:

   a. Dead Loads: Weights of materials and construction.
   b. Wind Loads: As indicated.

2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:

   a. Exterior Non-Load-Bearing Framing: Horizontal deflection of 1/600 of the wall height.

3. Design framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.

4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:

a. Upward and downward movement of 1/2 inch.

B. Cold-Formed Steel Framing, General: Design according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions."

1. Headers: Design according to AISI's "Standard for Cold-Formed Steel Framing - Header Design."
2. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

1.4 SUBMITTALS

A. Product Data: For each type of cold-formed metal framing product and accessory indicated.

B. Shop Drawings: Show layout, spacings, sizes, thicknesses, and types of cold-formed metal framing; fabrication; and fastening and anchorage details, including mechanical fasteners. Show reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

1. For cold-formed metal framing indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Welding certificates.

D. Product Test Reports: From a qualified testing agency, unless otherwise stated, indicating that each of the following complies with requirements, based on evaluation of comprehensive tests for current products:

1. Expansion anchors.
2. Power-actuated anchors.
3. Mechanical fasteners.
4. Vertical deflection clips.
5. Miscellaneous structural clips and accessories.

1.5 QUALITY ASSURANCE

A. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer.

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of cold-formed metal framing that are similar to those indicated for this Project in material, design, and extent.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code--Steel," and AWS D1.3, "Structural Welding Code--Sheet Steel."

D. AISI Specifications and Standards: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" and its "Standard for Cold-Formed Steel Framing - General Provisions."

1. Comply with AISI's "Standard for Cold-Formed Steel Framing - Header Design."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Store cold-formed metal framing, protect with a waterproof covering, and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:

1. Grade: As required by structural performance.
2. Coating: G90.

B. Steel Sheet for Vertical Deflection Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:

1. Grade: 50, Class 1 or 2.
2. Coating: G90.

2.2 EXTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch.
2. Flange Width: 1-5/8 inches.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch.
2. Flange Width: 1-1/4 inches.

C. Vertical Deflection Clips: Manufacturer's standard bypass clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

2.3 EXTERIOR CEILING JOIST, SOFFIT AND FASCIA FRAMING

A. Members: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0329 inch.
2. Flange Width: 1-5/8 inches, minimum.

2.4 INTERIOR SUSPENDED OVERHEAD FRAMING

A. Members: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0329 inch.
2. Flange Width: 1-5/8 inches, minimum.

2.5 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:

1. Supplementary framing.
2. Bracing, bridging, and solid blocking.
3. Web stiffeners.
4. Anchor clips.
5. End clips.
6. Foundation clips.
7. Stud kickers, knee braces, and girts.
8. Hole reinforcing plates.
9. Backer plates.
10. 18 Gauge galvanized steel flat strapping, 8 to 10-inches wide, in lieu of wood blocking to support millwork, toilet partitions, toilet accessories, et cetera, in metal stud walls.

2.6 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.

B. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

C. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 conducted by a qualified independent testing agency.

D. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.

1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.

E. Welding Electrodes: Comply with AWS standards.

2.7 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: ASTM A 780.

B. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, non-staining grout containing selected silica sands, portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents, complying with ASTM C 1107/C 1107M, with fluid consistency and 30-minute working time.

C. Shims: Load bearing, high-density multi-monomer plastic, and non-leaching; or of cold-formed steel of same grade and coating as framing members supported by shims.

D. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch (6.4 mm) thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

2.8 FABRICATION

A. Fabricate cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate framing assemblies using jigs or templates.
2. Cut framing members by sawing or shearing; do not torch cut.
3. Fasten cold-formed metal framing members by welding or screw fastening. Wire tying of framing members is not permitted.

a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by not less than three exposed screw threads.

4. Fasten other materials to cold-formed metal framing by welding or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.

C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
2. Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Cold-formed metal framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed metal framing according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions" and to manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.

1. Screw or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.

D. Install cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened.

1. Cut framing members by sawing or shearing; do not torch cut.
2. Fasten cold-formed metal framing members by welding or screw fastening. Wire tying of framing members is not permitted.

a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.

H. Install insulation, specified in Division 07 Section "Thermal Insulation," in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

I. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's standard punched openings.

J. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.3 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.

B. Fasten both flanges of studs to bottom track, unless otherwise indicated. Space studs as follows:

1. Stud Spacing: 16 inches, maximum.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.

1. Connect vertical deflection clips to bypassing studs and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.

1. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
2. Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, fasteners, and stud girts, to provide a complete and stable wall-framing system.

G. Install seal gaskets under all exterior metal stud walls.

3.4 EXTERIOR CEILING JOIST, SOFFIT AND FASCIA INSTALLATION

A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated on Shop Drawings.

B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.

1. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches.

2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections as indicated on Shop Drawings.

C. Space joists not more than 2 inches from abutting walls, and as follows:

1. Joist Spacing: 24 inches, maximum.

D. Frame openings with built-up joist headers consisting of joist and joist track, nesting joists, or another combination of connected joists if indicated.

E. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement, or as indicated on Shop Drawings.

F. Install bridging at intervals indicated on Shop Drawings. Fasten bridging at each joist intersection as follows:

1. Bridging: Joist-track solid blocking of width and thickness indicated, secured to joist webs.

G. Secure joists to load-bearing walls or supporting framing to prevent lateral movement of bottom flange.

H. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.5 INTERIOR SUSPENDED OVERHEAD FRAMING INSTALLATION

A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated on Shop Drawings.

B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.

1. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches.

2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections as indicated on Shop Drawings.

C. Space joists not more than 2 inches from abutting walls, and as follows:

1. Joist Spacing: 24 inches, maximum.

D. Frame openings with built-up joist headers consisting of joist and joist track, nesting joists, or another combination of connected joists if indicated.

E. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement, or as indicated on Shop Drawings.

F. Install bridging at intervals indicated on Shop Drawings. Fasten bridging at each joist intersection as follows:

1. Bridging: Joist-track solid blocking of width and thickness indicated, secured to joist webs.

G. Secure joists to load-bearing walls or supporting framing to prevent lateral movement of bottom flange.

H. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.6 SPECIAL INSPECTIONS

A. Special Inspections and tests shall be performed by the Special Inspector or Special Inspection Agency.

B. Verification and inspection of steel construction shall be in accordance with Table 1704.3 of 2012 North Carolina Building Code, and as follows:

1. Welding: Welding inspection shall be in compliance with AWS D1.3.

2. Details: Perform an inspection of the installed cold-formed metal framing to verify compliance with the details shown on the construction documents and approved shop drawings such as member size, gage, location and spacing, connection details and miscellaneous framing.

C. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

D. Additional testing performed to determine compliance of corrected work with specified requirements shall be at CMR's expense.

3.7 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed metal framing is without damage or deterioration at time of Acceptance by Owner.

END OF SECTION 054000

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Miscellaneous steel framing and supports.
2. Steel weld plates and angles.
3. Loose steel lintels.
4. Pipe and Tube Railings and Handrails.

PART 2 - PRODUCTS

2.1 METALS

A. Metal Surfaces, General: For metal fabrications exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

1. Steel plates, Shapes, and Bars: ASTM A 36/A 36M.
2. Stainless Steel Bars and Shapes: ASTM A276/A276M. Type 316L
3. Steel Tubing: ASTM A500/A500M
4. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T6.

2.2 FASTENERS

A. General: Type 304 or 316 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633, Class Fe/Zn 5, at exterior walls. Provide stainless steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.

B. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanize per ASTM F2329/F2329M.

C. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Gour 1 or Group 2 stainless steel bolts. ASTM F593, and nits, ASTM F594.

2.3 MISCELLANEOUS MATERIALS

A. Universal Shop Primer: Fast curing, lead and chromate-free, universal modified-alkyd primer complying with MPI #107.

B. Galvanizing Repair Paint: SSPC-Paint 20, high zinc-dust-content paint for re-galvanizing welds in steel.

C. Nonshrink, Nonmetallic Grout: Factory-packaged, non-staining, noncorrosive, nongaseous grout complying with ASTM C 1107.

D. Concrete Materials and Properties: Comply with requirements in Division 3 Section. “Cast-in-Place Concrete” for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi (20 Mpa), unless otherwise indicated.

2.4 FINISHES:

A. Comply with NAAMM's Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Finish metal fabrications after assembly.

B. Steel and Iron Finishes:

1. Hot-dip galvanize all exterior lintels, handrails and railings and other items as indicated to comply with ASTM A 123/A 123M or ASTM A 153/A 153M as applicable.

2. Preparation for Shop Priming: Prepare un-coated ferrous-metal surfaces to comply with requirements indicated below for environmental exposure conditions of installed metal fabrications:

a. Exteriors (SSPC Zone 1B) SSPC-SP 6/NACE No. 3. "Commercial Blast Cleaning.

3. Shop Priming: Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting," for shop painting.

END OF SECTION 055000

SECTION 055100 - METAL STAIRS, METAL PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Preassembled steel stairs with concrete-filled treads.
2. Industrial-type stairs with steel floor plate and grating treads.
3. Steel spiral stairs.
4. Steel tube railings attached to metal stairs.
5. Steel tube handrails attached to walls adjacent to metal stairs.

B. Related Sections include the following:

1. Division 03 Section "Cast-in-Place Concrete" for concrete fill for stair treads and platforms.
2. Division 05 Section "Metal Fabrications" for metal treads and nosings not installed in metal stairs.
4. Division 06 Section "Miscellaneous Rough Carpentry" for wood blocking for anchoring railings.
5. Division 09 Section “Resilient Base and Accessories” for applied tread and riser covering.
6. Division 9 Section “High Performance Coating” for painting metal surfaces that are exposed to view.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance of Stairs: Provide metal stairs capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load: 100 lbf/sq. ft.
2. Concentrated Load: 300 lbf applied on an area of 4 sq. in.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to L/360 or 1/4 inch, whichever is less.

B. Structural Performance of Railings: Provide railings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails:

a. Uniform load of 50 lbf/ ft. applied in any direction.
b. Concentrated load of 200 lbf applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

C. Seismic Performance: Provide metal stairs capable of withstanding the effects of earthquake motions determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

1.4 SUBMITTALS

A. Product Data: For metal stairs and the following:

1. Prefilled metal-pan stair treads.
2. Paint products.
3. Grout.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Provide templates for anchors and bolts specified for installation under other Sections.
2. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Samples for Initial Selection: For products involving selection of color, texture, or design.

D. Welding certificates.

E. Qualification Data: For professional engineer.

F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for stairs and railings.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for class of stair designated, unless more stringent requirements are indicated.

1. Preassembled Stairs: Commercial class.

C. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.3, "Structural Welding Code--Sheet Steel."

1.6 COORDINATION

A. Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

B. Coordinate locations of hanger rods and struts with other work so that they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.

C. Verify the upper floor elevation with the CMR and with the structural steel shop drawings to assure the heights of risers and landings are evenly spaced.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces, unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, raised welds, roller marks, rolled trade names, or blemishes.

2.2 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Steel Tubing: ASTM A 500 (cold formed) or ASTM A 513, Type 5 (mandrel drawn).

C. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

D. Steel Bars for Grating Treads: ASTM A 36/A 36M.

E. Wire Rod for Grating Crossbars: ASTM A 510.

F. Iron Castings: Either gray or malleable iron, unless otherwise indicated.

1. Malleable Iron: ASTM A 47/A 47M.

G. Uncoated, Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, either commercial steel, Type B, or structural steel, Grade 25, unless another grade is required by design loads; exposed.

2.3 ABRASIVE NOSINGS FOR EMBEDDING IN CONCRETE STEPS

A. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer. Length to be 8 inches shorter than tread; centered on the tread.

B. Apply bituminous paint to concealed bottoms, sides, and edges of cast-metal

units set into concrete.

C. Apply clear lacquer to concealed bottoms, sides, and edges of extruded units set into concrete.

2.4 FASTENERS

A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 25 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Anchor Bolts: ASTM F 1554, Grade 36.

1. Provide hot-dip or mechanically deposited, zinc-coated anchor bolts for exterior stairs.

D. Machine Screws: ASME B18.6.3.

E. Lag Bolts: ASME B18.2.1.

F. Plain Washers: Round, ASME B18.22.1.

G. Lock Washers: Helical, spring type, ASME B18.21.1.

H. Expansion Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

1. Material for Anchors in Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.

2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

D. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

E. Concrete Materials and Properties: Comply with requirements in Division 03 Section "Cast-in- Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.

2.6 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, struts, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Join components by welding, unless otherwise indicated.
2. Use connections that maintain structural value of joined pieces.
3. Fabricate treads and platforms of exterior stairs so finished walking surfaces slope to drain.

B. Preassembled Stairs: Assemble stairs in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Form exposed work true to line and level with accurate angles and surfaces and straight edges.

F. Weld connections to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Weld exposed corners and seams continuously, unless otherwise indicated.
5. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.

H. Fabricate joints that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

2.7 STEEL-FRAMED STAIRS

A. Stair Framing:

1. Fabricate stringers of steel plates or channels.

a. Provide closures for exposed ends of channel stringers.

2. Construct platforms of steel plate or channel headers and miscellaneous framing members as needed to comply with performance requirements indicated.
3. Weld stringers to headers; weld framing members to stringers and headers.
4. Where stairs are enclosed by gypsum board shaft-wall assemblies, provide hanger rods or struts to support landings from floor construction above or below. Locate hanger rods and struts where they will not encroach on required stair width and will be within the fire- resistance-rated stair enclosure.
5. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.

B. Metal-Pan Stairs: Form risers, subtread pans, and subplatforms to configurations shown from steel sheet of thickness needed to comply with performance requirements but not less than 0.0677 inch.

1. Steel Sheet: Uncoated cold-rolled steel sheet, unless otherwise indicated.
2. Directly weld metal pans to stringers; locate welds on top of subtreads where they will be concealed by concrete fill. Do not weld risers to stringers.
3. Shape metal pans to include nosing integral with riser.
4. At CMR's option, provide stair assemblies with metal-pan subtreads filled with reinforced concrete during fabrication.
5. Provide sub-platforms of configuration indicated or, if not indicated, the same as sub-treads. Weld sub-platforms to platform framing.

a. Smooth Soffit Construction: Construct sub-platforms with smooth soffits, where exposed to view.

2.8 STEEL TUBE RAILINGS

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of tube, post spacings, and anchorage, but not less than that needed to withstand indicated loads.

1. Configuration: As indicated and detailed. Each stair needs railings at two different heights.

B. Welded Connections: Fabricate railings with welded connections. Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

C. Form changes in direction of railings as follows:

1. As detailed.

D. Close exposed ends of railing members with prefabricated end fittings.

E. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.

F. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work. Furnish inserts and other anchorage devices for connecting to

concrete or masonry work.

1. Connect posts to stair framing by direct welding, unless otherwise indicated.
2. Use all galvanized railings. Provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous-metal components.
3. For nongalvanized railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors embedded in exterior masonry and concrete construction.

G. Fillers: Provide fillers made from galvanized steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.

2.9 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal stairs after assembly. Galvanizing: Hot-dip galvanize all items to comply with applicable standard listed below:

ASTM A 123/A 123M, for galvanizing steel and iron products. ASTM A 153/A 153M, for galvanizing steel and iron hardware. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete, unless otherwise indicated.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

E. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

F. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

G. Place and finish concrete fill for treads and platforms to comply with Division 03 Section "Cast- in-Place Concrete."

1. Install abrasive nosings with anchors fully embedded in concrete. Center nosings on tread width.

3.2 INSTALLING METAL STAIRS WITH GROUTED BASEPLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of baseplates.

B. Set steel stair baseplates on wedges, shims, or leveling nuts. After stairs have been positioned and aligned, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.

1. Use nonmetallic, nonshrink grout, unless otherwise indicated.
2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.3 INSTALLING STEEL TUBE RAILINGS

A. Adjust railing systems before anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated or, if not indicated, as required by design loads. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:

1. Anchor posts to steel by welding directly to steel supporting members.
2. Anchor handrail ends to concrete and masonry with steel round flanges welded to rail ends and anchored with postinstalled anchors and bolts.

B. Attach handrails to wall with wall brackets. Provide bracket with 1-1/2-inch clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads. Secure wall brackets to building construction as follows:

1. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt.
2. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
3. For hollow masonry anchorage, use toggle bolts.

END OF SECTION 055100

SECTION 055213 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Exterior aluminum handrails.
   2. Exterior aluminum guardrails.

1.3 COORDINATION

A. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project

B. site in time for installation.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

   1. Manufacturer's product lines of mechanically connected railings.
   2. Railing brackets.
   3. Grout, anchoring cement, and paint products.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

   1. Shop drawings for pipe and tube railings are to be signed and sealed by a qualified professional engineer currently licensed to practice in North Carolina.

C. Samples: For each type of exposed finish required.

   1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters, including finish.
   2. Fittings and brackets.
   3. Assembled Sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Sample need not be full height.

      a. Show method of connecting and finishing members at intersections.

D. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Welding certificates.

C. Mill Certificates: Signed by manufacturers of stainless-steel products certifying that products furnished comply with requirements.

D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

E. Product Test Reports: For pipe and tube railings, for tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

F. Evaluation Reports: For post-installed anchors, from ICC-ES.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

1.8 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 GUARDRAILS

A. Guardrail with aluminum infill panel:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Greco Aluminum Panel Rail or comparable product by one of the following:
   2. Manufacturer: Greco Architectural Metal Products
   3. Model: Panel Infill Railing G506A
   4. Height: Refer to Drawings.

B. Source Limitations: Obtain each type of railing from single source from single manufacturer.

2.2 HANDRAILS

A. Handrail
   1. Design: Refer to Drawings.

2. Height: Refer to Drawings.
3. Material: Anodized Aluminum, to match guardrail finish.

B. Source Limitations: Obtain each type of railing from single source from single manufacturer.

2.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design railings, including attachment to building construction.

B. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:

a. Uniform load of 50 lbf/ ft. applied in any direction.
b. Concentrated load of 200 lbf applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Deflection Limits:

a. Maximum Deflection Limit: 0.60 inches unless current code requires more stringent limit.

1) Limit based on NC State Building Code and International Building Code for structural system requirements to not exceed most restrictive deflection limits.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.4 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.
1. Provide formed stainless steel brackets with predrilled hole for bolted anchorage and with snap-on cover that matches rail finish and conceals bracket base and bolt head and that provides 1-1/2-inch clearance from inside face of handrail to finished wall surface.

2.5 STAINLESS STEEL

A. Tubing: ASTM A 554, Grade MT 304.

2.6 FASTENERS

A. General: Provide the following:
   1. Stainless-Steel Railings: Type 304 stainless-steel fasteners.
   2. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

B. Fasteners for Interconnecting Railing Components:

   1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.

2.7 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

   1. For stainless-steel railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

B. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

C. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

   1. Water-Resistant Product: At exterior locations provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.8 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that are exposed to weather in a manner that excludes water. Provide weep holes where water may accumulate.

F. Connections: Fabricate railings with welded connections unless otherwise indicated.

G. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove flux immediately.
4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

H. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.

I. Form Changes in Direction as Follows:

1. As detailed.

J. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

K. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.

L. For railing posts set in concrete, provide stainless-steel sleeves not less than 8 inches long with inside dimensions not less than 1/2 inch greater than outside dimensions of post, with metal plate forming bottom closure.

2.9 STAINLESS-STEEL FINISHES

A. Remove tool and die marks and stretch lines, or blend into finish.

B. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

C. Directional Satin Finish: No. 4, or as needed to match finish of exterior illuminated railings.

D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements are clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1. Coat, with a heavy coat of bituminous paint, concealed surfaces of aluminum that are in contact with grout, concrete, masonry, wood, or dissimilar metals.

D. Adjust railings before anchoring to ensure matching alignment at abutting joints.

E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.

B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches of post.

3.4 ANCHORING POSTS

A. Use metal sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions.

B. Form or core-drill holes not less than 8 inches deep and 3/4 inch larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions.

C. Cover anchorage joint with flange of same metal as post as indicated.

D. Leave anchorage joint exposed with 1/8-inch buildup, sloped away from post.

3.5 ADJUSTING AND CLEANING

A. Clean stainless steel by washing thoroughly with clean water and soap and rinsing with clean water.

3.6 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Final Acceptance.

END OF SECTION 055213

SECTION 055300 - METAL GRATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Metal bar gratings.
2. Metal frames and supports for gratings.

B. Related Sections include the following:

1. Division 05 Section "Structural Steel" for structural-steel framing system components.
2. Division 05 Section "Metal Stairs, Pipe and Tube Railings " for grating treads and landings of steel-framed stairs, and for metal pipe and tube handrails and railings.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance of Gratings: Provide gratings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Walkways and Elevated Platforms Used as Exits: Uniform load of 100 lbf/sq. ft.
2. Limit deflection to L/360 or 1/4 inch, whichever is less.

B. Seismic Performance: Provide gratings capable of withstanding the effects of earthquake motions determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures" : Section 9, "Earthquake Loads."

1.4 SUBMITTALS

A. Product Data: For the following:

1. Clips and anchorage devices for gratings.
2. Paint products.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Provide templates for anchors and bolts specified for installation under other Sections.

2. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Welding certificates.

D. Qualification Data: For professional engineer.

1.5 QUALITY ASSURANCE

A. Metal Bar Grating Standards: Comply with NAAMM MBG 531, "Metal Bar Grating Manual" and NAAMM MBG 532, "Heavy-Duty Metal Bar Grating Manual."

B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.3, "Structural Welding Code--Sheet Steel."

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating gratings without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
2. Provide allowance for trimming and fitting at site.

1.7 COORDINATION

A. Coordinate installation of anchorages for gratings, grating frames, and supports. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Metal Bar Gratings:

a. Alabama Metal Industries Corporation.
b. All American Grating, Inc.
c. Barnett/Bates Corp.
d. Fisher & Ludlow.
e. IKG Industries; a Harsco Company.
f. Marwas Steel Co.; Laurel Steel Products Division.
g. Ohio Gratings, Inc.
h. Seidelhuber Metal Products, Inc.
i. Tru-Weld.

2.2 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Wire Rod for Grating Crossbars: ASTM A 510.

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners for and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts, and, where indicated, flat washers; ASTM F 593 for bolts and ASTM F 594 for nuts, Alloy Group 1.

D. Plain Washers: Round, ASME B18.22.1.

E. Lock Washers: Helical, spring type, ASME B18.21.1.

F. Anchors: Provide cast-in-place, chemical or torque-controlled expansion anchors with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

1. Material for Anchors in Interior Locations: Carbon-steel components zinc-plated to
2. comply with ASTM B 633, Class Fe/Zn 5.

2.4 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy that is welded.

B. Zinc-Rich Primer: Zinc-rich primer, complying with SSPC-Paint 20 or SSPC-Paint 29 and compatible with topcoat.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Benjamin Moore & Co.; Epoxy Zinc-Rich Primer CM18/19.
    b. Carboline Company; Carbozinc 621.
    c. ICI Devoe Coatings; Catha-Coat 313.
    d. PPG Architectural Finishes, Inc.; Aquapon Zinc-Rich Primer 97-670.
    e. Sherwin-Williams Company (The); Corothane I GalvaPac Zinc Primer.
    f. Tnemec Company, Inc.; Tneme-Zinc 90-97.

B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.5 FABRICATION

A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.

D. Fit exposed connections accurately together to form hairline joints.

E. Welding: Comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

F. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.

1. Fabricate toeplates for attaching in the field.
2. Toeplate Height: 4 inches, unless otherwise indicated.

2.6 METAL BAR GRATINGS

A. Welded Steel Grating:

1. Bearing Bar Spacing: 11/16-inch o.c.
2. Bearing Bar Depth: As required to comply with structural performance requirements.
3. Bearing Bar Thickness: As required to comply with structural performance requirements.
4. Crossbar Spacing: 2 inches o.c.
5. Traffic Surface: Serrated.
6. Steel Finish: Shop primed.

C. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.

1. Edge-band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.

C. Do not notch bearing bars at supports to maintain elevation.

2.7 GRATING FRAMES AND SUPPORTS

A. Frames and Supports for Metal Gratings: Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware

and similar items.

1. Unless otherwise indicated, fabricate from same basic metal as gratings.
2. Equip units indicated to be cast into concrete or built into masonry with integrally welded anchors. Unless otherwise indicated, space anchors 24 inches o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches wide by 1/4 inch thick by 8 inches long.

2.10 STEEL FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish gratings, frames, and supports after assembly.

C. Hot Dip Galvanize all components to comply with ASTM A 123/A 123M or ASTM A 153/A 153M as applicable.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

D. Fit exposed connections accurately together to form hairline joints.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

E. Attach toeplates to gratings by welding at locations indicated.

F. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

G. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout,

concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.2 INSTALLING METAL BAR GRATINGS

A. General: Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.

B. Attach nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

3.3 INSTALLING METAL PLANK GRATINGS

A. General: Comply with manufacturer's written instructions for installing gratings. Use manufacturer's standard anchor clips and hold-down devices for bolted connections.

3.4 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

END OF SECTION 055300

SECTION 061053 - MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wood blocking and nailers.
2. Wood furring.
3. Wood sleepers.
4. Plywood backing panels.
5. Plywood for roof edge framing.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1.3 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For the following, from ICC-ES:

1. Preservative-treated wood.
2. Fire-retardant-treated wood.
3. Power-driven fasteners.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece.
3. Provide dressed lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat all miscellaneous carpentry unless otherwise indicated.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.

1. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.

C. Application: Treat items indicated on Drawings, and the following:

1. Plywood backing panels.
2. Elsewhere as noted on the Drawings.

2.4 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.
3. Furring.

B. For items of dimension lumber size, provide Construction or No. 2 grade lumber of any species. At exterior walls and roof use pressure-treated lumber (PTW) Grade UC4A.

C. For concealed boards, provide lumber with 15 percent maximum moisture content and of the following species and grade:

1. Mixed southern pine, No. 2 grade; SPIB.

2.5 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 1/2-inch (13-mm) nominal thickness.

1. Plywood shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 PLYWOOD FOR ROOF EDGE FRAMING

A. DOC PS 1, Exterior, C-D, preservative treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

2.7 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Power-Driven Fasteners: NES NER-272.

C. Screws for Fastening to Metal Framing: ASTM C 1002, length as recommended by screw manufacturer for material being fastened.

2.8 TPO MEMBRANE BETWEEN CONCRETE/CMU AND PTW OR METAL DECKING

A. Fabric-Reinforced Thermoplastic Polyolefin Sheet: ASTM D 6878, internally fabric or scrim reinforced, uniform, flexible fabric backed TPO sheet.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Carlisle SynTec Incorporated.
b. Firestone Building Products Company.
c. GAF Materials Corporation.
d. Johns Manville.

2. Thickness: 45 mils (1.1 mm), nominal.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit.

B. Where wood-preservative-treated lumber is installed adjacent to metal decking or concrete/concrete masonry, install continuous flexible flashing separator (TPO) between wood and metal decking or concrete/concrete masonry.

C. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

D. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels.

E. Do not splice structural members between supports unless otherwise indicated.

F. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

G. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. NES NER-272 for power-driven fasteners.
2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
3. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.

3.2 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061053

SECTION 061600 - SHEATHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wall sheathing and soffit panels under EIFS finish system or EIFS coating.
2. Sheathing joint and penetration treatment.
3. Marine plywood sheathing at interior curved walls.

B. Related Sections Include:

1. 042100, Unit Masonry.
2. 054000, Cold-Formed Metal Framing.
3. 061053, Miscellaneous Rough Carpentry.
4. 072100, Thermal Insulation.
5. 072419, Water Drainage Exterior Insulation and Finish System (EIFS)
6. 072726, Fluid-Applied Membrane Air Barrier
7. 084113, Aluminum-Framed Entrances and Storefronts.
8. 084414, Glazed Aluminum Curtain Walls.
9. 092900, Gypsum Board.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

PART 2 - PRODUCTS

2.1 WALL SHEATHING

A. Glass-Mat Gypsum Sheathing Board: ASTM C 1177/C 1177M, with fiberglass mat laminated to both sides and with manufacturer's standard edges. Use for EIFS backer board and exterior soffits.

1. Type and Thickness: Regular, 1/2 inch (13 mm) thick.

2.2 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. For wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

2.3 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

A. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C 834, compatible with sheathing tape and sheathing and recommended by tape and

sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.

1. Sheathing Tape: Self-adhering glass-fiber tape, minimum 2 inches (50 mm) wide, 10 by 10 or 10 by 20 threads/inch (390 by 390 or 390 by 780 threads/m), of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing and with a history of successful in-service use.

2.4 SPECIAL WALL SHEATHING FOR INTERIOR CURVED SURFACES

A. APA 1/4" B-B Marine Grade Plywood with MDO surfaces.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:

1. Table 2304.9.1, "Fastening Schedule," in ICC's "International Building Code."

D. Coordinate wall sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

3.2 GYPSUM SHEATHING INSTALLATION

A. Comply with GA-253 and with manufacturer's written instructions.

1. Fasten gypsum sheathing to cold-formed metal framing with screws.
2. Install boards with a 3/8-inch (9.5-mm) gap where non-load-bearing construction abuts structural elements.
3. Install boards with a 1/4-inch (6.4-mm) gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.

B. Seal sheathing joints according to sheathing manufacturer's written instructions.

1. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel silicone emulsion sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.

END OF SECTION 061600

SECTION 062700 – FIBERGLASS SCULPTURE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Polystyrene foam block
2. Fiberglass fabric
3. Polyester resin
4. Timber and Steel framing

1.2 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

PART 2 - PRODUCTS

2.1 MATERIALS TO CREATE SCULPTURE OF WHALE TAIL – WHERE SHOWN ON THE DRAWINGS

A. Extruded polystyrene, 1-pound density, sized as required to sculpt item.

1. Provide latex protective coating material.

B. Fiberglass Materials for Touch Tank. Basis of Design Products are as manufactured by Evercoat Marine. Product by other manufacturers having the same properties will be acceptable.

1. Glass fiber fabric: 6 oz. “Sea-glass”,
2. Polyester resin: Catalyzing resin mixed with methyl-ethyl-ketone, “Boat Yard Resin”.
3. Laminating resin.
4. Polyester gel coat and coloring agent.

C. Materials for suspending the Sculpture. Match sizes used for the current mounting which will be dismantled.

1. ¾-inch APA B-B marine plywood and PTW lumber for anchoring the sculpture.
2. ¼-inch 316 stainless steel plate for anchoring the sculpture.
3. Stainless steel eye hook and cable for suspending the sculpture.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of the finished sculpture.

B. Carve polystyrene foam to required shape. Encase the timber plywood and steel in the foam.

C. Coat the assembly in protective latex. Apply fiberglass and gelcoat.

D. Securely bolt the sculpture to existing, adjoining piece and attach to ceiling by stainless steel cable.

E. The sculpture will resemble the existing whale tail and be adjusted to upward stroke of swimming position to clear the adjacent pedestrian walkway passage.

F. Finish the assembly to match the rest of the existing sculpture, with detailed markings including barnacles.

END OF SECTION 062700

SECTION 064023 – INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plastic-laminate cabinets, including acrylic polymer composite countertops and facing material, where shown.

B. Related Sections:

1. 061053, Miscellaneous Rough Carpentry.
2. 079200, Joint Sealants.
3. 090000, Color Schedule.
4. 092216, Non-Structural Metal Framing. Assure dimension lumber or galvanized steel strapping is installed for blocking to support cabinets.
5. 096513, Resilient Base and Accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product, including panel products, high-pressure decorative laminate, adhesive for bonding plastic laminate, and cabinet hardware and accessories.

B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.

C. Samples:

1. Plastic laminates, for each color, pattern, and surface finish.
2. PVC edge banding.
3. Samples of each solid surface material.

1.3 QUALITY ASSURANCE

A. Fabricator Qualifications: AWI membership.

B. Installer Qualifications: Fabricator of products.

1.4 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PLASTIC-LAMINATE-FACED ARCHITECTURAL CABINETS

A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of architectural plastic-laminate cabinets indicated for construction, finishes, installation, and other requirements.

B. Grade: Custom.

C. Type of Construction: Frameless.

D. Cabinet, Door, and Drawer Front Interface Style: Flush overlay.

E. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by woodwork quality standard.

1. Manufacturers: Subject to compliance with requirements, [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Formica Corporation.
b. Lamin-Art, Inc.
c. Wilsonart International; Div. of Premark International, Inc.(Basis of Design Product).

F. Laminate Cladding for Exposed Surfaces:

1. Horizontal Surfaces: Grade HGS 107HW.
2. Vertical Surfaces: Grade VGS 335HW.
3. Pattern Direction: Vertically for drawer fronts, doors, and fixed panels.

G. Materials for Semi-exposed Surfaces:

1. Surfaces Other Than Drawer Bodies Thermoset decorative panels.
2. Drawer Sides and Backs: Thermoset decorative panels with PVC or polyester edge banding.
3. Drawer Bottoms: Thermoset decorative panels.

H. Optional drawer construction: Manufactured drawer units with integral heavy-duty drawer slides (Blum Metabox, or equivalent).

I. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces as selected by the Architect. Refer to 090000 “Color Schedule”.

2.2 WOOD CABINETS AND WALL PANELS FOR TRANSPARENT FINISH

A. Grade: Premium.

B. Type of Construction: Frameless.

C. Cabinet and Door and Drawer Front Interface Style: Flush overlay.

D. Wood for Exposed Surfaces:

1. Species: White oak.

2. Cut: Rift cut/rift sawn.
3. Grain Direction: Vertically for drawer fronts, doors, and fixed panels.
4. Matching of Veneer Leaves: Book match.
5. Veneer Matching within Panel Face: Running match.
6. Wood panels for wall applications shall match the cabinet species, cut, grain direction and veneer matching.

E. Semi-exposed Surfaces: Provide surface materials indicated below:

1. Surfaces Other Than Drawer Bodies: Thermoset decorative panels or a compatible species to that indicated for exposed surfaces, stained to match.
2. Drawer Sub-fronts, Backs, and Sides: Solid-hardwood lumber, stained to match species indicated for exposed surfaces or thermoset decorative panels with PVC or polyester edge banding.
3. Drawer Bottoms: Hardwood plywood or thermoset decorative panels.

2.3 OTHER MATERIALS

A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.

1. Wood Moisture Content: 5 to 10 percent.

B. Composite Wood and Agri-fiber Products: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.

1. Medium-Density Fiberboard: ANSI A208.2, Grade 130, made with binder containing no urea formaldehyde.
2. Softwood Plywood: DOC PS 1, Exterior Glue, medium-density overlay.
3. Thermoset Decorative Panels: Particleboard or medium-density fiberboard finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD 3, Grade VGL, for test methods 3.3, 3.4, 3.6, 3.8, and 3.10.
4. Marine Grade plywood will be required at all countertop sinks: cut from 4’ x 8’ x ¾-inch A-B grade panel,

C. Acrylic polymer composite countertops and facing sheets - “Solid Surface”: Basis of Design, Formica “Signatures”, or equivalent product in function and appearance by Wilsonart and Corian. Refer to Color Schedule 090000 for selected Corian color/pattern. ½ - inch material with edges built up to 1 1/2 – inches.

D. Engineered quartz countertops. Provide MSI, Silestone, Caesarstone, or equivalent; color to be selected by the architect from manufacturer’s full range. 20 mm material with edges built up to 1 37.5 mm.

2.4 CABINET HARDWARE AND ACCESSORIES

A. General: Provide cabinet hardware and accessory materials associated with architectural woodwork, except for items specified in Division 08 Section "Door Hardware." **Substitutions that do not meet the intent of the specifications below (i.e.- requesting to substitute concealed hinges or line-bored shelving supports) will not be considered.**

B. Butt Hinges: 2-3/4-inch (70-mm), 5-knuckle steel hinges made from 0.095-inch- (2.4-mm-) thick metal, and as follows:

1. Semi-concealed Hinges for Overlay Doors: BHMA A156.9, B01521; Hospital Tip.

C. Adjustable Shelf Standards and Supports for wall shelves: BHMA A156.9, with shelf brackets and rests: Knape & Vogt 85/185, or equivalent.

D. Adjustable Shelf Standards and Supports for interior cabinet shelves: BHMA A156.9, B04013; Knape & Vogt 255/256 Series, or equivalent.

E. Work Station Brackets: 1/8-inch thick powder coated steel capable of supporting 1000 pounds; sized 24 inches by 29 inches, 1 ½ inch forms with multiple ¼ inch mounting holes per side and 3 inch notch at elbow for wire management. Finish: matte black.

F. Grommets for Countertop Wire Management: As manufactured by the Doug Mockett Company, www.mockett.com: Flip-Top Grommet Model XG3, matte black. Products by Wurth Lewis and Co, and Richelieu Building Specialties meeting the specifications for appearance and performance will be acceptable.

G. Back-Mounted Pulls: BHMA A156.9, B02011.

H. Wire Pulls: Back mounted, solid metal, 4 inches (100 mm) long, 5/16 inch (8 mm) in diameter.

I. Catches: Roller catches, BHMA A156.9, B03071 or Ball friction catches, BHMA A156.9, B03013.

J. Drawer Slides: BHMA A156.9, B05091.

1. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-extension type; zinc-plated steel ball-bearing slides.

K. Door Locks: BHMA A156.11, E07121; keyed to building system.

L. Drawer Locks: BHMA A156.11, E07041; keyed to building system.

M. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.

1. Satin Stainless Steel: BHMA 630.

2.5 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.

B. Adhesives, General: Adhesives shall not contain urea formaldehyde.

A. VOC Limits for Installation Adhesives: Installation adhesives hall have a VOC content of 30 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

C. Adhesives: Do not use adhesives that contain urea formaldehyde.

D. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Adhesive for Bonding Plastic Laminate: Contact cement.

1. Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.

F. Adhesives for bonding Solid Surface Counter Tops to substrate: Adhesive: Type recommended by solid surface manufacturer.

2.7 FABRICATION

A. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

B. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

C. Fabrication of Solid Surface Counter Tops:

1. Cut composite panels accurately to required shapes and dimensions.
2. Radius exposed edges.
3. Fabricate with hairline joints.
4. Cut holes for sinks, faucets, and toilet accessories.

D. Provide 3 mm pvc edge banding on all exposed edges of doors and drawers; Canplast or equivalent. Exposed edges of cabinet boxes may be self-edged laminate VGS.

E. Provide HGS finish on the tops of all wall-hung and full-height cabinets as well as the countertops.

2.8 SHOP FINISHING FOR WOOD CABINETS AND WALL PANELS FOR TRANSPARENT FINISH

A. General: Finish architectural wood cabinets at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.

B. Finish Materials: Use finish materials that meet the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural wood cabinets, as applicable to each unit of work.

1. Back priming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of cabinets.

D. Transparent Finish:

1. Grade: Premium.
2. Finish: System - 11, catalyzed polyurethane.
3. Wash Coat for Closed-Grain Woods: Apply wash-coat sealer to cabinets made from closed-grain wood before staining and finishing.
4. Staining: Match Architect's sample.
5. Sheen: Satin, 31-45 gloss units measured on 60-degree gloss meter per ASTM D 523.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before installation, condition cabinets to average prevailing humidity conditions in installation areas.

3.2 INSTALLATION

A. Grade: Install cabinets to comply with same grade as item to be installed.

B. Install cabinets level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm).

C. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

D. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork.

E. Cabinets: Install without distortion so doors and drawers will fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.

1. Install cabinets with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) sag, bow, or other variation from a straight line.
2. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches (400 mm) o.c. with No. 10 wafer-head screws sized for not less than 1-1/2-inch (38-mm) penetration into metal framing, wood blocking, or hanging strips.

F. All locations where millwork abuts walls shall be sealed with clear silicone for the entire length of exposure (top/backsplash or side).

END OF SECTION 064116

SECTION 066010 - PULTRUDED INDUSTRIAL GRATING
(FIBERGLASS REINFORCED PLASTICS - FRP - FABRICATIONS)

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The CONTRACTOR shall furnish, fabricate (where necessary), and install all fiberglass reinforced plastic (FRP) items, with all appurtenances, accessories and incidentals necessary to produce a complete, operable and serviceable installation as shown on the Contract Drawings and as specified herein, and in accordance with the requirements of the Contract Documents.

1.2 REFERENCES

A. The publications listed below (latest revision applicable) form a part of this specification to the extent referenced herein. The publications are referred to within the text by the designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) Test Methods:

ASTM D 635 Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position

ASTM D 732 Shear Strength of Plastics by Punch Tool

ASTM E 84 Surface Burning Characteristics of Building Materials

1.3 SUBMITTALS

A. Shop drawings of all fabricated gratings and accessories in accordance with the provisions of this Section.

B. Shop drawings clearly showing material sizes, types, styles, part or catalog numbers, complete details for the fabrication of and erection of components including, but not limited to, location, lengths, type and sizes of fasteners, clip angles, member sizes, and connection details.

C. Published literature including structural design data, structural properties data, grating load/deflection tables, corrosion resistance tables, certificates of compliance, test reports as applicable, concrete anchor systems and their allowable load tables, and design calculations for systems not sized or designed in the contract documents.

D. Sample pieces of each item specified herein for acceptance by the ENGINEER as to quality and color. Sample pieces shall be manufactured by the method to be used in the WORK.

1.4 QUALITY ASSURANCE

A. All items to be provided under this Section shall be furnished only by manufacturers having a minimum of ten (10) years experience in the design and manufacture of similar products and

systems. Additionally, if requested, a record of at least five (5) previous, separate, similar successful installations in the last five (5) years shall be provided.

B. Manufacturer shall offer a 3 year limited warranty on all FRP products against defects in materials and workmanship.

C. Manufacturer shall be certified to the ISO 9001-2008 standard.

D. Manufacturer shall provide proof of certification from at least two other quality assurance programs for its facilities or products (DNV, ABS, USCG, AARR).

1.5 PRODUCT DELIVERY AND STORAGE

A. Delivery of Materials: Manufactured materials shall be delivered in original, unbroken pallets, packages, containers, or bundles bearing the label of the manufacturer. Adhesives, resins and their catalysts and hardeners shall be crated or boxed separately and noted as such to facilitate their movement to a dry indoor storage facility.

B. Storage of Products: All materials shall be carefully handled to prevent them from abrasion, cracking, chipping, twisting, other deformations, and other types of damage. Store items in an enclosed area and free from contact with soil and water. Store adhesives, resins and their catalysts and hardeners in dry indoor storage facilities between 70 and 85 degrees Fahrenheit (21 to 29 degrees Celsius) until they are required.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Pultruded grating shall be based on Safe-T-Span® as manufactured by:

Fibergrate Composite Structures Inc.
5151 Belt Line Road, Suite 1212
Dallas, Texas 75254-7028 USA
(800) 527-4043 Phone (972) 250-1530 Fax

Website: www.fibergrate.com
E-mail: info@fibergrate.com

B. Products meeting the requirements of this specification include but are not limited to:

1. Strongwell Corporation. www.strongwell.com.

2. Bedford Reinforced Plastics. www.bedfordreinforced.com.

2.2 GENERAL

A. All FRP items furnished under this Section shall be composed of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements and dimensions as necessary to meet the design requirements and dimensions as specified in the Contract Documents.

B. Fiberglass reinforcement shall be a combination of continuous roving, continuous strand mat, and surfacing veil in sufficient quantities as needed by the application and/or physical

properties required.

C. Resins shall be ISOPHTHALIC with chemical formulations as necessary to provide the corrosion resistance, strength and other physical properties as required.

D. All finished surfaces of FRP items and fabrications shall be smooth, resin-rich, free of voids and without dry spots, cracks, crazes or unreinforced areas. All glass fibers shall be well covered with resin to protect against their exposure due to wear or weathering.

E. All pultruded structural shapes shall be further protected from ultraviolet (UV) light with 1) integral UV inhibitors in the resin and 2) a synthetic surfacing veil to help produce a resin rich surface.

F. All FRP products shall have a tested flame spread rating of 25 or less per ASTM E-84 Tunnel Test. Gratings shall not burn past the 25 mm reference mark and will be classified HB per ASTM D635.

G. All grating clips shall be manufactured of Type 316SS (stainless steel).

2.3 PULTRUDED GRATING

A. Manufacture: Grating components shall be high strength and high stiffness pultruded elements having a maximum of 70% and a minimum of 60% glass content (by weight) of continuous roving and continuous strand mat fiberglass reinforcements. The finished surface of the product shall be provided with a surfacing veil to provide a resin rich surface which improves corrosion resistance and resistance to ultraviolet degradation. Bearing bars shall be interlocked and epoxied in place with a two-piece cross rod system to provide a mechanical and chemical lock. Cross rods should be below the walking surface of the grating. Gratings with cross rods that are flush with the walking surface are excluded.

B. Non-slip surfacing: Grating shall be provided with a quartz grit bonded and baked to the top surface of the finished grating product.

C. Fire rating: Grating shall be fire retardant with a tested flame spread rating of 25 or less when tested in accordance with ASTM E 84. Manufacturer may be required to provide certification of ASTM E84 test on grating panels from an independent testing laboratory. Test data shall be from full scale testing of actual production grating, of the same type and material supplied on the project. Test data performed only on the base resin shall not be acceptable.

D. Resin system: The resin system used in the manufacture of the grating shall be ISOFR. Manufacturer may be required to submit corrosion data from tests performed on actual grating products in standard chemical environments. Corrosion resistance data of the base resin from the manufacturer is not a true indicator of grating corrosion resistance and shall not be accepted.

E. Color: Gray or Yellow.

F. Depth: 1" deep load bars with a tolerance of plus or minus 1/32".

G. Mesh Configuration: 1-1/2" load bar spacing, 6" tie bar spacing on centers. Grating shall be SAFE-T-SPAN® I6010V or I6010I as manufactured by **Fibergrate Composite Structures Incorporated.**

H. Load/Deflection: Grating shall meet manufacturers published safe recommended loadings with deflection not to exceed the following:

Uniform distributed load over a 48" span: 50 pounds per square foot, with a maximum deflection of 0.14".

I. Substitutions: Other products of equal strength, stiffness, corrosion resistance and overall quality may be submitted with the proper supporting data to the engineer for approval.

2.4 GRATING FABRICATION

A. Measurements: Grating supplied shall meet the minimum dimensional requirements as shown or specified. The Contractor shall provide and/or verify measurements in field for work fabricated to fit field conditions as required by grating manufacturer to complete the work. Determine correct size and locations of required holes or cutouts from field dimensions before grating fabrication.

B. Layout: Each grating section shall be readily removable, except where indicated on drawings. Manufacturer to provide openings and holes where located on the contract drawings. Grating supports shall be provided at openings in the grating by contractor where necessary to meet load/deflection requirements specified herein. Grating openings which fit around protrusions (pipes, cables, machinery, etc.) shall be discontinuous at approximately the centerline of opening so each section of grating is readily removable.

C. Sealing: All shop fabricated grating cuts shall be coated with vinyl ester resin to provide maximum corrosion resistance. All field fabricated grating cuts shall be coated similarly by the contractor in accordance with the manufacturer's instructions.

D. Hardware: Type 316 stainless steel hold-down clips shall be provided and spaced at a maximum of four feet apart with a minimum of four per piece of grating, or as recommended by the manufacturer.

PART 3 - EXECUTION

3.1 INSPECTION

A. Shop inspection is authorized as required by the Owner and shall be at Owner's expense. The fabricator shall give ample notice to Contractor prior to the beginning of any fabrication work so that inspection may be provided. The grating shall be as free, as commercially possible, from visual defects such as foreign inclusions, delamination, blisters, resin burns, air bubbles and pits.

3.2 INSTALLATION

A. Contractor shall install gratings in accordance with manufacturer’s assembly drawings. Lock grating panels securely in place with hold-down fasteners as specified herein. Field cut and drill fiberglass reinforced plastic products with carbide or diamond tipped bits and blades. Seal cut or drilled surfaces in accordance with manufacturer's instructions. Follow manufacturer's instructions when cutting or drilling fiberglass products or using resin products; provide adequate ventilation.

END OF SECTION

SECTION 066050 - MOLDED STAIR TREADS - FIBERGLASS REINFORCED PLASTICS (FRP)

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The CONTRACTOR shall furnish, fabricate (where necessary), and install all fiberglass reinforced plastic (FRP) items, with all appurtenances, accessories and incidentals necessary to produce a complete, operable and serviceable installation as shown on the Contract Drawings and as specified herein, and in accordance with the requirements of the Contract Documents.

1.2 REFERENCES

A. The publications listed below (latest revision applicable) form a part of this specification to the extent referenced herein. The publications are referred to within the text by the designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) Test Methods:

ASTM D 635 Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in Horizontal Position

ASTM E 84 Surface Burning Characteristics of Building Materials

1.3 SUBMITTALS

A. Shop drawings of all fabricated stair treads and accessories in accordance with the provisions of this Section.

B. Manufacturer's shop drawings clearly showing material sizes, types, styles, part or catalog numbers, complete details for the fabrication of and erection of components including, but not limited to, location, lengths, type and sizes of fasteners, support member sizes, and connection details.

C. Manufacturer’s published literature including structural design data, structural properties data, stair tread load/deflection tables, corrosion resistance tables, certificates of compliance, test reports as applicable, concrete anchor systems and their allowable load tables (as applicable) and design calculations for systems not sized or designed in the contract documents.

D. Sample pieces of each Fibertred® item specified herein for acceptance by the ENGINEER as to quality and color. Sample pieces shall be manufactured by the method to be used in the WORK.

1.4 QUALITY ASSURANCE

A. All items to be provided under this Section shall be furnished only by manufacturers having a minimum of ten (10) years experience in the design and manufacture of similar products and systems. Additionally, if requested, a record of at least five (5) previous, separate, similar successful installations in the last five (5) years shall be provided.

B. Manufacturer shall offer a 3 year limited warranty on all FRP products against defects in materials and workmanship.

C. Manufacturer shall be certified to the ISO 9001-2008 standard.

D. Manufacturer shall provide proof of certification from at least two other quality assurance programs for its facilities or products (DNV, ABS, USCG, AARR).

1.5 PRODUCT DELIVERY AND STORAGE

A. Delivery of Materials: Manufactured materials shall be delivered in original, unbroken pallets, packages, containers, or bundles bearing the label of the manufacturer. Adhesives, resins and their catalysts and hardeners shall be crated or boxed separately and noted as such to facilitate their movement to a dry indoor storage facility.

B. Storage of Products: All materials shall be carefully handled to prevent them from abrasion, cracking, chipping, twisting, other deformations, and other types of damage. Store adhesives, resins and their catalysts and hardeners in dry indoor storage facilities between 70 and 85 degrees Fahrenheit (21 to 29 degrees Celsius) until they are required.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Stair treads shall be based on Fibertred® as manufactured by:

Fibergrate Composite Structures Inc.
5151 Belt Line Road, Suite 1212
Dallas, Texas 75254-7028 USA
(800) 527-4043 Phone (972) 250-1530 Fax

Website: www.fibergrate.com
E-mail: info@fibergrate.com

B. Products meeting the requirements of this specification include but are not limited to:

1. Strongwell Corporation. www.strongwell.com.

2. Bedford Reinforced Plastics. www.bedfordreinforced.com.

2.2 GENERAL

A. All FRP items furnished under this Section shall be composed of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements and dimensions as necessary to meet the design requirements and dimensions as specified in the Contract Documents.

B. Fiberglass reinforcement shall be continuous roving in sufficient quantities as needed by the application and/or physical properties required.

C. Resin shall be Isophthalic Polyester, with chemical formulations as necessary to provide the corrosion resistance, strength and other physical properties as required.

D. All finished surfaces of FRP items and fabrications shall be smooth, resin-rich, and as free as commercially possible of voids, dry spots, cracks, crazes or unreinforced areas. All glass fibers

shall be well covered with resin to protect against their exposure due to wear or weathering.

E. All stair tread products shall have a tested flame spread rating of 25 or less per ASTM E-84 Tunnel Test. Stair treads shall not burn past the 25 mm reference mark and will be classified HB per ASTM D635.

F. All mechanical stair tread clips and fasteners shall be manufactured of Type 316SS (stainless steel).

2.3 STAIR TREADS

A. Manufacture: Stair treads shall be FIBERTRED® as manufactured by Fibergrate Composite Structures Incorporated. Fibertred® stair treads shall be of a one-piece molded construction and shall have a 1-1/2" x 6" rectangular mesh pattern providing unidirectional strength in the tread span direction. Fibertred® shall be reinforced with continuous rovings in each direction. The top layer of reinforcement shall be no more than 1/8" below the top surface of the tread so as to provide maximum stiffness and prevent resin chipping of unreinforced surfaces. Percentage of glass (by weight) shall not exceed 35% so as to achieve maximum corrosion resistance, and as required to maintain the structural requirements of the CONTRACT. After molding, no dry glass fibers shall be visible on any surface of bearing bars or cross bars. All bars shall be smooth and uniform with no evidence of fiber orientation irregularities, interlaminar voids, porosity, resin rich or resin starved areas.

B. Non-slip surfacing: Fibertred® stair treads shall be manufactured with a concave, meniscus profile on the top of each bar providing maximum slip resistance. For additional safety, and to meet OSHA requirements, stair treads shall be manufactured with a 1-1/2" solid, molded nosing. Nosing shall be gritted with an angular quartz grit, integrally molded into the top surface of the nosing area only.

C. Fire rating: Fibertred® stair treads shall be fire retardant with a tested flame spread rating of 25 or less when tested in accordance with ASTM E 84. Test data performed only on the resin shall not be accepted.

D. Resin system: The resin system used in the manufacture of Fibertred® stair treads shall be {Vi-Corr®, FGI-AM®, Corvex®, ELS, XFR or Super Vi-Corr® - choose one}. Manufacturer may be required to submit corrosion data from tests performed on actual stair tread products in standard chemical environments. Corrosion resistance data of the base resin from the manufacturer is not a true indicator of stair tread product corrosion resistance and shall not be accepted.

E. Thickness: 1-1/2" thick with a tolerance of plus or minus 1/16".

F. Mesh Configuration: 1-1/2" x 6" rectangular mesh pattern with double cross bars on 6" centers which allows optimum utilization and ease of fabrication.

G. Load/Deflection: Fibertred® stair treads shall meet manufacturer's published recommended loading with deflection not to exceed the following:

Concentrated load of 500 pounds, placed at the centerline of a 36" tread span with a maximum deflection not to exceed 0.32".

The concentrated load is applied at the centerline of the tread, over a width of 4" and a depth of 6", starting at the nosing edge to simulate the landing of a foot.

H. The manufacturer shall certify that the stiffness of all panels manufactured are never more than 2.5% below the published load-deflection values.

I. Substitutions: Other products of equal strength, stiffness, corrosion resistance and overall quality may, with prior approval, be submitted with the proper supporting data to the engineer for approval.

2.4 STAIR TREAD FABRICATION

A. Measurements: Fibertred® stair treads supplied shall meet the dimensional requirements and tolerances as shown or specified. The Contractor shall provide and/or verify measurements in field for work fabricated to conform to field conditions as required by stair tread manufacturer to complete the work. When field dimensions are not required, contractor shall determine correct size and locations of required holes or cutouts from field dimensions before grating fabrication.

B. Sealing: All shop fabricated stair tread cuts shall be coated with vinyl ester resin to provide maximum corrosion resistance. All field fabricated stair tread cuts shall be coated similarly by the contractor in accordance with the manufacturer's instructions.

C. Hardware: Type 316 stainless steel hold-down clips shall be provided and spaced as recommended by the manufacturer. A minimum of four hold-down clips shall be required for each tread.

PART 3 - EXECUTION

3.1 INSPECTION

A. Shop inspection is authorized as required by the Owner and shall be at Owner's expense. The fabricator shall give ample notice to Contractor prior to the beginning of any fabrication work so that inspection may be provided. The Fibertred® stair treads shall be as free, as commercially possible, from visual defects such as foreign inclusions, delamination, blisters, resin burns, air bubbles and pits. The surface shall have a smooth finish (except for grit top surfaces).

3.2 INSTALLATION

A. Contractor shall install Fibertred® stair treads in accordance with manufacturer’s assembly drawings. Fasten stair treads securely in place with hold-down fasteners as specified herein. Field cut and drill fiberglass reinforced plastic products with carbide or diamond tipped bits and blades. Seal cut or drilled surfaces in accordance with manufacturer's instructions. Follow manufacturer's instructions when cutting or drilling fiberglass products or using resin products; provide adequate ventilation.

SECTION 066100 - PULTRUDED FIBERGLASS STRUCTURAL SHAPES

(FIBERGLASS REINFORCED PLASTICS (FRP) FABRICATIONS)

PART 1 - GENERAL

1.0 GENERAL

1.1 REFERENCES

The publications listed below (latest revision applicable) form a part of this specification to the extent referenced herein. The publications are referred to within the text by the designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) Test Methods:

ASTM D-638-Tensile Properties of Plastics

ASTM D-790-Flexural Properties of Unreinforced and Reinforced Plastics

ASTM D-2344-Apparent Interlaminar Shear Strength of Parallel Fiber Composites by Short Beam Method

ASTM D-696-Coefficient of Linear Thermal Expansion for Plastics

ASTM E-84-Surface Burning Characteristics of Building Materials

NSF/ANSI STANDARD 61

1.2 SUBMITTALS

A. Shop drawings of all fabricated structural systems and accessories in accordance with the provisions of this Section.

B. Shop drawings clearly showing material sizes, types, styles, part or catalog numbers, complete details for the fabrication of and erection of components including, but not limited to, location, lengths, type and sizes of fasteners, clip angles, member sizes, and connection details.

C. Published literature including structural design data, structural properties data, corrosion resistance tables, certificates of compliance, test reports as applicable, and design calculations for systems not sized or designed in the contract documents, sealed by a Professional Engineer.

D. Submit sample pieces of each item specified herein for acceptance by the ENGINEER as to quality and color. Sample pieces shall be manufactured by the method to be used in the WORK.

1.3 QUALITY ASSURANCE

A. All items to be provided under this Section shall be furnished only by manufacturers having a minimum of ten (10) years' experience in the design and manufacture of similar products and systems. Additionally, if requested, a record of at least five (5) previous, separate, similar successful installations in the last five (5) years shall be provided.

B. Manufacturer shall offer a 3-year limited warranty on all FRP products against defects in materials and workmanship.

C. Manufacturer shall be certified to the ISO 9001-2008 standard.

D. Manufacturer shall provide proof of certification from at least two other quality assurance programs for its facilities or products (DNV, ABS, USCG, AARR).

E. Manufacturer shall provide proof, via independent testing, that materials proposed as a solution do not contain heavy metals in amounts greater than that allowed by current EPA requirements.

1.4 PRODUCT DELIVERY AND STORAGE

A. Delivery of Materials: Manufactured materials shall be delivered in original, unbroken pallets, packages, containers, or bundles bearing the label of the manufacturer. Adhesives, resins and their catalysts and hardeners shall be crated or boxed separately and noted as such to facilitate their movement to a dry indoor storage facility.

B. Storage of Products: All materials shall be carefully handled to prevent them from abrasion, cracking, chipping, twisting, and other types of damage. Store adhesives, resins and their catalysts and hardeners in dry indoor storage facilities between 70 and 85 degrees Fahrenheit (21 to 29 degrees Celsius) until they are required.

PART 2 - MATERIALS

2.1 MANUFACTURER

A. Structural shapes are based on Dynaform® as manufactured by:

Fibergrate Composite Structures Inc.
5151 Belt Line Road, Suite 1212
Dallas, Texas 75254-7028 USA
(800) 527-4043 Phone (972) 250-1530 Fax

Website: www.fibergrate.com
E-mail: info@fibergrate.com

B. Products meeting the requirements of this specification include but are not limited to:

1. Strongwell Corporation. www.strongwell.com.
2. Bedford Reinforced Plastics. www.bedfordreinforced.com.
3. AMICO FRP Products. www.seasafe.com/custom-fabrication.
5. AMD Inc. www.amdgrating.com.

2.2 GENERAL

A. All structural shapes are to be manufactured by the pultrusion process with a glass content minimum of 45%, maximum of 55% by weight. The structural shapes shall be composed of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements and dimensions as necessary to meet the design requirements and dimensions as specified in the Contract Documents.

B. Fiberglass reinforcement shall be a combination of continuous roving, continuous strand mat, and surfacing veil in sufficient quantities as needed by the application and/or physical properties required.

C. Resins shall be {DYNAFORM® ISO, non-fire retardant isophthalic polyester or *ISO, non-fire retardant isophthalic polyester used to produce NSF Standard 61 certified shapes*; ISOFR, fire retardant isophthalic polyester; *VE, non-fire retardant vinyl ester used to produce NSF Standard 61 certified shapes* or VEFR, fire retardant vinyl ester, (*choose one*)} with chemical formulation necessary to provide the corrosion resistance, strength and other physical properties as required.

D. All finished surfaces of FRP items and fabrications shall be smooth, resin-rich, free of voids and without dry spots, cracks, crazes or unreinforced areas. All glass fibers shall be well covered with resin to protect against their exposure due to wear or weathering.

E. All pultruded structural shapes shall be further protected from ultraviolet (UV) attack with 1) integral UV inhibitors in the resin and 2) a synthetic surfacing veil to produce a resin rich surface.

F. All *fire retardant* FRP products shall have a tested flame spread rating of 25 or less per ASTM E-84 Tunnel Test.

G. All shapes products shall be certified to NSF/ANSI Standard 61 *{use only if choosing a resin system that can be used to produce shapes to the NSF Standard 61 in sections 2.2 C}.*

2.3 Pultruded structural shapes are to have the minimum longitudinal mechanical properties listed below:

Property	**ASTM Method**	**Value**	**Units**
Tensile Strength	D-638	30,000 (206)	psi (MPa)
Tensile Modulus	D-638	2.5×10^6 (17.2)	psi (GPa)
Flexural Strength	D-790	30,000 (206)	psi (MPa)
Flexural Modulus	D-790	1.8×10^6 (12.4)	psi (GPa)
Flexural Modulus (Full Section)	N/A	2.8×10^6 (19.3)	psi (GPa)
Short Beam Shear (Transverse)	D-2344	4,500 (31)	psi (MPa)
Shear Modulus (Transverse)	N/A	4.5×10^5 (3.1)	psi (GPa)
Coefficient of Thermal Expansion	D-696	4.4×10^{-6} (8.0×10^{-6})	in/in/°F (cm/cm/°C)
Flame Spread	E-84	25 or less	N/A

PART 3 - EXECUTION

3.0 FABRICATION

A. Measurements: Structural Shapes supplied shall meet the minimum dimensional requirements as shown or specified. The Contractor shall provide and/or verify measurements in field for work fabricated to fit field conditions as required by manufacturer to complete the work. Determine correct size and locations of required holes or coping from field dimensions before structural shape fabrication.

B. Sealing: All shop fabricated cuts or drilling shall be coated with vinyl ester resin to provide maximum corrosion resistance. All field fabricated cuts or drilling shall be coated similarly by the contractor in accordance with the manufacturer's instructions.

C. Hardware: Type 316 stainless steel bolts shall be provided.

3.1 INSPECTION

A. Shop inspection is authorized as required by the Owner and shall be at Owner's expense. The fabricator shall give ample notice to Contractor prior to the beginning of any fabrication work so that inspection may be provided. The structural shapes shall be as free, as commercially possible, from visual defects such as foreign inclusions, delamination, blisters, resin burns, air bubbles and pits.

END OF SECTION

SECTION 068113 – PULTRUDED ROUND PROFILE GUARDRAIL AND HANDRAIL
(FIBERGLASS REINFORCED PLASTICS – FRP - FABRICATIONS)

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This specification is for a pultruded round fiberglass railing system in compliance with 2015 IBC and OSHA 1910.29 Fall Protection and Falling Object Protection.

1.2 REFERENCES

A. The publications listed below (latest revision applicable) form a part of this specification to the extent referenced herein. The publications are referred to within the text by the designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) Test Methods:

ASTM D-638-Tensile Properties of Plastics

ASTM D-790-Flexural Properties of Unreinforced and Reinforced Plastics

ASTM D-2344-Apparent Interlaminar Shear Strength of Parallel Fiber Composites by Short Beam Method

ASTM D-696-Coefficient of Linear Thermal Expansion for Plastics

ASTM E-84-Surface Burning Characteristics of Building Materials

INTERNATIONAL CODE COUNCIL, INC.
The International Building Code, 2015

THE OCCUPATIONAL HEALTH AND SAFETY ADMINISTRATION
Code of Federal Regulations (CFR), Title 29, Section 1910.29

1.3 SUBMITTALS

A. Shop drawings of all fabricated railings and accessories in accordance with the provisions of this Section.

B. Shop drawings clearly showing material sizes, types, styles, part or catalog numbers, complete details for the fabrication of and erection of components including, but not limited to, location, lengths, type and sizes of fasteners, clip angles, member sizes, and connection details.

C. Manufacturer's published literature including structural design data, structural properties data, corrosion resistance tables, certificates of compliance, test reports as applicable, and design calculations for systems not sized or designed in the contract documents, sealed by a Professional Engineer.

D. Sample pieces of each item specified herein for acceptance by the ENGINEER as to quality and color. Sample pieces shall be manufactured by the method to be used in the WORK.

1.4 QUALITY ASSURANCE

A. All items to be provided under this Section shall be furnished only by manufacturers having a minimum of ten (10) years' experience in the design and manufacture of similar products and systems. Additionally, if requested, a record of at least five (5) previous, separate, similar successful installations in the last five (5) years shall be provided.

B. Manufacturer shall offer a 3-year limited warranty on all FRP products against defects in materials and workmanship.

C. Manufacturer shall be certified to the ISO 9001-2008 standard.

D. Manufacturer shall provide proof of certification from at least two other quality assurance programs for its facilities or products (DNV, ABS, USCG, AARR).

1.5 PRODUCT DELIVERY AND STORAGE

A. Delivery of Materials: Manufactured materials shall be delivered in original, unbroken pallets, packages, containers, or bundles bearing the label of the manufacturer. Adhesives, resins and their catalysts and hardeners shall be crated or boxed separately and noted as such to facilitate their movement to a dry indoor storage facility.

B. Storage of Products: All materials shall be carefully handled to prevent them from abrasion, cracking, chipping, twisting, other deformations, and other types of damage. Adhesives, resins and their catalysts are to be stored in dry indoor storage facilities between 70 and 85 degrees Fahrenheit (21 to 29 degrees Celsius) until they are required.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Guardrail and/or Handrail system are based on DynaRound™ as manufactured by

Fibergrate Composite Structures Inc.
5151 Belt Line Road, Suite 1212
Dallas, Texas 75254-7028 USA
(800) 527-4043 Phone (972) 250-1530 Fax

Website: www.fibergrate.com
E-mail: info@fibergrate.com

B. Products meeting the requirements of this specification include but are not limited to:

1. Strongwell Corporation. www.strongwell.com.

2. Bedford Reinforced Plastics. www.bedfordreinforced.com.

2.2 GENERAL

A. All posts and rails are to be DYNAFORM® FRP structural shapes manufactured by the pultrusion process. The structural shapes shall be composed of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements and dimensions as necessary to meet the design requirements and dimensions specified in the Contract Documents.

B. Fiberglass reinforcement shall be a combination of continuous roving, continuous strand mat,

and surfacing veil in sufficient quantities as needed by the application and/or physical properties required.

C. Resin shall be DYNAFORM® VEFR, fire retardant vinyl ester with chemical formulation necessary to provide the corrosion resistance, strength and other physical properties as required.

D. All finished surfaces of FRP items and fabrications shall be smooth, resin-rich, free of voids and without dry spots, cracks, crazes or unreinforced areas. All glass fibers shall be well covered with resin to protect against their exposure due to wear or weathering.

E. All pultruded structural shapes shall be further protected from ultraviolet (UV) attack with 1) integral UV inhibitors in the resin, 2) a synthetic surfacing veil to help produce a resin rich surface, and 3) an appropriate UV resistant coating for outdoor exposures.

F. All FRP products shall have a tested flame spread rating of 25 or less per ASTM E-84 Tunnel Test.

G. Horizontal rails and vertical posts for guardrails are to be 1.9" OD x 0.2" wall (48.3 mm x 5.1 mm) round tube and the kick plate is to be ½" deep x 4" wide x 0.125" thick (12.7 mm x 101.6 mm x 3.2 mm) with two reinforcing corrugations. Offset rail used as handrail is to be 1.5" OD x 0.25" wall (38.1 mm x 6.4 mm) round tube.

H. The completed guardrail installation shall meet the following load requirements with a minimum factor of safety of 2.0:

Concentrated Load: 200 lb (891 N) applied in any direction at any point on the top rail.

Uniform Load: 50 lb/lf (730.5 N/m) applied in any direction on the top rail.

Loads are assumed not to act concurrently.

I. All rails, posts, and kick plates are to be integrally pigmented yellow.

J. The pultruded 1.9" OD x 0.2" wall (48.3 mm x 5.1 mm) round tube is to have the minimum longitudinal mechanical properties listed below:

Property	**ASTM Method**	**Value**	**Units**
Flexural Strength (Full Section)	---	70,000 (482)	psi (MPa)
Flexural Modulus (Full Section)	---	5.0×10^6 (34.4)	psi (GPa)
Short Beam Shear (Transverse)	D-2344	4,500 (31)	psi (MPa)
Shear Modulus (Transverse)	N/A	4.5×10^5 (3.1)	psi (GPa)
Density	D792	0.062 – 0.070 (1.71 – 1.93)	lb/in^3 (g/cc)
Coefficient of Thermal Expansion	D-696	8.0×10^{-6} (1.4×10^{-6})	in/in/°F (cm/cm/°C)
Flame Spread	E-84	25 or less	N/A

K. All fasteners used in the railing system are to be AISI 316 stainless steel. Rivets and rivet nuts are to be AISI 304 stainless steel.

PART 3 - EXECUTION

3.0 FABRICATION

A. The post/rail connections for the 1.9" OD x 0.2" wall guardrail system are to be fabricated using molded, glass reinforced saddle connectors. The saddle connectors are to be attached to the tubes via bonding and riveting. The saddle connectors are to be connected to the adjoining tubes or connectors with 316SS 1/4” diameter bolts and/or 304SS rivet nuts as required. No sharp, protruding edges are to remain after assembly of the railing system. No PVC or CPVC connectors are to be used as a load carrying component of the railing system. Spacing of the posts for horizontal runs is not to exceed 4’-0" (1.22 m). Spacing of posts for inclined runs and offset handrail supports shall not exceed 3’-6” (1.07 m).

B. The bases of guardrail posts are to be secured according to the contract drawings. The bases of the posts are to be internally reinforced to a height of 8.5" (216 mm). Posts are to be detailed with drain features that prevent the accumulation of water inside of the posts.

C. The 1.5” OD x 0.25” wall round tube offset handrail is to be installed at a height of 34 inches above the walking surface and/or stair nosings and extend beyond the upper and lower treads as required to comply with governing building codes. The ends of the offset handrail are to terminate via a smooth, molded transition into the guardrail or wall. The offset handrails are to be attached to guards or walls with brackets fabricated from 316 stainless steel and/or FRP components. The configuration of the offset handrail brackets is to meet all IBC 2015 graspability requirements.

D. For inline splices, the 1.9" OD x 0.2" wall horizontal rails are to be spliced using a 10" (152.4 mm) length of 1.5” OD x 1/4" (38.1 mm x 6.4 mm) FRP round tube bonded and riveted into place using epoxy adhesive. Inline splices for offset handrail to be a 5” (127 mm) length of 1” diameter (25.4 mm) FRP solid round rod.

E. For 90 degree splices, both the 1.9" OD x 0.2" wall horizontal rails and the 1.5” OD x 0.25” wall round tube offset handrail are to be spliced using a specially molded component which smoothly transitions between the spliced tubes with a constant radius. The spliced tubes are to be bonded and riveted to this molded 90-degree splice.

F. For non-90 degree splices, both the 1.9" OD x 0.2" wall horizontal rails and the 1.5” OD x 0.25” wall round tube offset handrail are to be connected using a molded adjustable splice which can be adjusted to an included angle of 180 to 39 degrees. The ends of the spliced tube are to be mitered to achieve a minimum-gap butt joint. The spliced tubes are to be bonded and riveted to the molded splice.

G. All shop fabricated cuts are to be sealed to provide maximum corrosion resistance. Field cuts are to be similarly coated by the contractor in accordance with the manufacturer’s instructions.

END OF SECTION

SECTION 071326 - SELF-ADHERING SHEET WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes self-adhering modified bituminous sheet waterproofing.

B. Locations: In elevator pits.

C. Pre-installation Conference: Conduct conference at Project Site.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show locations and extent of waterproofing and details of substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.

1.3 INFORMATIONAL SUBMITTALS

A. Sample warranties.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.

1.5 WARRANTY

A. Manufacturer's Warranty: Manufacturer's standard materials-only warranty in which manufacturer agrees to furnish replacement waterproofing material for waterproofing that does not comply with requirements or that fails to remain watertight within specified warranty period.

1. Warranty Period: Five years from date of Acceptance by Owner.

PART 2 - PRODUCTS

2.1 MODIFIED BITUMINOUS SHEET WATERPROOFING

A. Modified Bituminous Sheet: Minimum 60-mil (1.5-mm) nominal thickness, self-adhering sheet consisting of 56 mils (1.4 mm) of rubberized asphalt laminated on one side to a 4-mil- (0.10-mm-) thick, polyethylene-film reinforcement, and with release liner on adhesive side; formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. American Hydrotech, Inc.; VM75.
    b. Carlisle Coatings & Waterproofing Inc.; CCW MiraDRI 860/861.
    c. CETCO Building Materials Group, a subsidiary of AMCOL International Corp.; Envirosheet.
    d. Grace, W. R., & Co. - Conn.; Bituthene 4000.
    e. Tamko Building Products, Inc.; TW-60.
    f. York Manufacturing, Inc.; HydroGard.

2. Physical Properties:

    a. Tensile Strength, Membrane: 325 psi minimum; ASTM D 412.
    b. Ultimate Elongation: 350 percent minimum; ASTM D 412.
    c. Low-Temperature Flexibility: Pass at minus 20 deg F (minus 29 deg C); ASTM D 1970.
    d. Crack Cycling: Unaffected after 100 cycles of 1/8-inch (3-mm) movement; ASTM C 836.
    e. Puncture Resistance: 60 lbf minimum; ASTM E 154.
    f. Water Absorption: 0.1 percent weight-gain maximum after 48-hour immersion at 70 deg F (21 deg C); ASTM D 570.
    g. Water Vapor Permeance: 0.05 perms maximum; ASTM E 96/E 96M, Water Method.
    h. Hydrostatic-Head Resistance: 230 feet minimum; ASTM D 5385.

3. Sheet Strips: Self-adhering, rubberized-asphalt strips of same material and thickness as sheet waterproofing.

2.2 AUXILIARY MATERIALS

A. General: Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.

1. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.

B. Substrate Patching Membrane: Low-viscosity, two-component, modified asphalt coating.

C. Metal Termination Bars: Aluminum bars, approximately 1 by 1/8-inch (25 by 3 mm) thick, predrilled at 9-inch (229-mm) centers.

2.3 INSULATION DRAINAGE PANELS

A. Unfaced Wall-Insulation Drainage Panels: 1 inch thick extruded-polystyrene board insulation complying with ASTM C 578, Type VI, 40-psi (276-kPa) minimum compressive strength; unfaced; fabricated with shiplap or channel edges and with one side having grooved drainage channels.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. DiversiFoam Products; CertiFoam 40 (with channel edges) Drainage Board.
    b. Dow Chemical Company (The); Styrofoam Perimate.
    c.

2.4 STORM SUB-DRAIN AND FOUNDATION DRAIN PIPING

A. Storm Sub-Drain Pipe and Fittings: SCH 40 PVC or dual-wall, smooth interior HDPE as specified above, with ½-in drilled perforations. Minimum 4-inch diameter unless otherwise indicated on the drawings. Non perforated pipe shall be used outside of area to be drained to connect sub-drains to drainage inlets.

B. Filter Fabric: Non-woven geotextile Drainage (Filter) Fabric conforming to NCDOT Section 956-1.

PART 3 - EXECUTION

3.1 MODIFIED BITUMINOUS SHEET-WATERPROOFING APPLICATION

A. Prepare surfaces and install modified bituminous sheets according to waterproofing manufacturer's written instructions and recommendations in ASTM D 6135.

B. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by sheet waterproofing in same day. Re-prime areas exposed for more than 24 hours.

C. Apply and firmly adhere sheets over area to receive waterproofing. Accurately align sheets and maintain uniform 2-1/2-inch- (64-mm-) minimum lap widths and end laps. Overlap and seal seams, and stagger end laps to ensure watertight installation.

1. When ambient and substrate temperatures range between 25 and 40 deg F (minus 4 and plus 5 deg C), install self-adhering, modified bituminous sheets produced for low-temperature application. Do not use low-temperature sheets if ambient or substrate temperature is higher than 60 deg F (16 deg C).

D. Apply continuous sheets over already-installed sheet strips, bridging substrate cracks, construction, and contraction joints.

E. Seal edges of sheet-waterproofing terminations with mastic.

F. Install sheet-waterproofing and auxiliary materials to tie into adjacent waterproofing.

G. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fish mouths and blisters. Patch with sheet waterproofing extending 6 inches (150 mm) beyond repaired areas in all directions.

H. Immediately install protection course with butted joints over waterproofing membrane.

1. Molded-sheet drainage panels may be used in place of a separate protection course to vertical applications when approved by waterproofing manufacturer and installed immediately.

3.2 INSULATION DRAINAGE-PANEL INSTALLATION

A. Install insulation drainage panels over waterproofed surfaces; cut and fit to within 3/4 inch (19 mm) of projections and penetrations.

B. Ensure that drainage channels are aligned and free of obstructions.

C. On vertical surfaces, set insulation drainage panels in adhesive or tape applied according to manufacturer's written instructions.

D. On horizontal surfaces, loosely lay insulation drainage panels according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

3.3 PROTECTION, REPAIR, AND CLEANING

A. Do not permit foot or vehicular traffic on unprotected membrane.

B. Protect installed insulation drainage panels from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

C. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

D. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 071326

SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Foam-plastic board insulation at foundations.
2. Glass-fiber blanket insulation, including for sound attenuation.

B. **Insulation requirements are based on Climate Zone 3 and must meet or exceed the minimum requirements of this zone.**

C. Related Sections:

1. 033000, Cast-in Place Concrete.
2. 035100, Tectum III Roof Deck.
3. 074100, Metal Wall Panel Rain Screen System.
4. 074219, Water Drainage Exterior Insulation and Finish System (EIFS).
5. 075422, Thermoplastic Polyolefin Roofing
7. 092216, Non-Structural Metal Framing.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.3 INSTALLER QUALIFICATIONS FOR SPRAY FOAM INSULATION

A. The installer must be certified for this type of insulation installation by the manufacturer of the product and have installed a minimum of ten projects of at least 5,000 square feet of material, each.

PART 2 - PRODUCTS

2.1 FOAM-PLASTIC BOARD INSULATION

A. Extruded-Polystyrene Board Insulation (XPS): ASTM C 578, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.

1. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. DiversiFoam Products.

b. Dow Chemical Company (The).
c. Owens Corning.

2. Type IV, 25 psi (173 kPa), **2-inch thickness, for R-10, down the foundation wall.**

2.2 GLASS-FIBER BLANKET INSULATION (BATT INSUL.)

A. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. CertainTeed Corporation.
2. Johns Manville.
3. Owens Corning.

B. Unfaced Glass-Fiber Blanket Insulation: ASTM C 665, **6-inch thickness for R-19.** For use as sound attenuation in all partitions between Mechanical Rooms and occupied spaces and between occupied spaces, and in exterior metal stud walls.

C. Unfaced Glass-Fiber Blanket Insulation: ASTM C 665, **10-inch thickness for R-30.** For use as insulation exterior GWB soffits.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

D. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.

E. Care must be taken to prevent aerosolized material from damaging adjacent structures and vehicles. Notify the Building Owner prior to spraying the insulation material and assure that all vehicles that could be damaged are move out of harm’s way. Protect portions of adjacent structure that may be damaged.

F. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

G. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

H. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.2 INSTALLATION OF BELOW-GRADE INSULATION

A. Retain first option in first paragraph below if support is required during backfilling.

B. On vertical surfaces, set insulation units loosely laid according to manufacturer's written instructions.

1. If not otherwise indicated, extend insulation from the outer edge of the horizontal perimeter insulation down to the top of the footing (refer to wall section drawings).

C. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

1. If not otherwise indicated, extend insulation a minimum of 24 inches (610 mm) in from exterior walls.

3.3 INSTALLATION OF INSULATION WITHIN FRAMED CONSTRUCTION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Glass-Fiber Insulation: Install in cavities formed by framing members according to the following requirements:

2. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.

3. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.

4. Install in miscellaneous voids to provide continuous insulation.

C. Lay soffit batt insulation in one or two layers. If in two layers, place the second layer perpendicular to the first.

END OF SECTION 072100

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SECTION 072419 - WATER DRAINAGE EXTERIOR INSULATION AND FINISH SYSTEM (EIFS)

PART 1 GENERAL

1.1 SUMMARY

A. Provide a super hydrophobic EIFS system.

B. Provide air and moisture barrier, and compatible EIFS for vertical above grade exterior walls.

C. Provide ultra-high impact resistance on surfaces below 6-feet above finish floor height.

D. Related Sections

1. Section 042000: Unit Masonry
2. Section 061053: Miscellaneous Rough Carpentry
3. Section 061600: Sheathing, for exterior soffit board and wall sheathing.
4. Section 072100: Insulation
5. Section 076200: Sheet Metal Flashing and Trim
6. Section 079200: Joint Sealants
7. Section 084113: Aluminum-Framed Entrances and Storefronts

1.2 SUBMITTALS

A. Manufacturer's specifications, details, installation instructions and product data

B. Manufacturer’s code compliance report or test summary

C. Manufacturer's standard warranty

D. Applicator's industry training credentials

E. Samples for approval as directed by architect or owner

F. EPS board manufacturer's ICC ES Evaluation Report or UL Listing

G. Sealant manufacturer's certificate of compliance with ASTM C 1382

H. Product sample finish in the color selected by the Architect.

I. Letter from the System Manufacturer stating the details provided in the Contract Documents comply with the Warranty requirements; or submit alternate details that will comply with the project-specific requirements.

1.3 REFERENCES

A. ASTM Standards:

B 117 Test Method for Salt Spray (Fog) Testing

C 297 Standard Test Method for Flatwise Tensile Strength of Sandwich

Constructions

C 578	Specification for Preformed, Cellular Polystyrene Thermal Insulation
C 1177	Specification for Glass Mat Gypsum for Use as Sheathing
C 1382	Test Method for Determining Tensile Adhesion Properties of Sealants When Used in Exterior Insulation and Finish Systems (EIFS) Joints
D 968	Test Method for Abrasion Resistance of Organic Coatings by Falling Abrasive
D 1784	Specification for Rigid Poly (Vinyl Chloride) (PVC) and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
D 2247	Practice for Testing Water Resistance of Coatings in 100% Relative Humidity
D 3273	Test for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
E 72	Standard Test Methods of Conducting Strength Tests of Panels for Building Construction
E 84	Test Method for Surface Burning Characteristics of Building Materials
E 96	Test Methods for Water Vapor Transmission of Materials
E 119	Method for Fire Tests of Building Construction and Materials
E 2098	Test Method for Determining Tensile Breaking Strength of Glass Fiber Reinforcing Mesh for Use in Class PB Exterior Insulation and Finish System after Exposure to a Sodium Hydroxide Solution
E 2134	Test Method for Evaluating the Tensile-Adhesion Performance of an Exterior Insulation and Finish System (EIFS)
E 2178	Test Method for Air Permeance of Building Materials
E 2273	Test Method for Determining the Drainage Efficiency of Exterior Insulation and Finish System (EIFS) Clad Wall Assemblies
E 2357	Standard Test Method for Determining Air Leakage of Air Barrier Assemblies
E 2485	Standard Test Method for Freeze/Thaw Resistance of Exterior Insulation and Finish Systems (EIFS) and Water Resistive Barrier Coatings
E 2486	Standard Test Method for Impact Resistance of Class PB and PI Exterior Insulation and Finish Systems (EIFS)
E 2568	Standard Specification for PB Exterior Insulation and Finish Systems
E 2570	Test Method for Water-Resistive (WRB) Coatings used Under Exterior Insulation and Finish Systems (EIFS) or EIFS with Drainage

B. Building Code Standards

AC 235	Acceptance Criteria for EIFS Clad Drainage Wall Assemblies (November, 2009)

C. National Fire Protection Association (NFPA) Standards

NFPA 268	Standard Test Method for Determining Ignitability of Exterior Wall

Assemblies Using a Radiant Heat Energy Source

NFPA 285 Standard Method of Test for the Evaluation of Flammability Characteristics of Exterior Non-Load-Bearing Wall Assemblies containing Combustible Components Using the Intermediate-Scale, Multistory Test Apparatus

D. Other Referenced Documents

1. American Association of Textile Chemists and Colorists AATCC-127 Water Resistance: Hydrostatic Pressure Test
2. APA Engineered Wood Association E 30, Engineered Wood Construction Guide
3. ICC-ES ESR-1233, StoGuard with Gold Coat, StoGuard with EmeraldCoat, and StoGuard VaporSeal Water-Resistive Barriers and StoEnergy Guard
4. ICC-ES ESR-1748, StoTherm® ci

1.4 DESIGN REQUIREMENTS

A. Wind Load

1. Design for maximum allowable system deflection, normal to the plane of the wall, of L/240.
2. Design for wind load in conformance with NCSBC code requirements.
3. Maximum wind load resistance: ± 175 psf (8.37 kPa), provided structural supports and sheathing/sheathing attachment are adequate to resist these pressures.

B. Moisture Control

1. Prevent the accumulation of water behind the EIFS or into the wall assembly, either by condensation or leakage through the wall construction, in the design and detailing of the wall assembly:
   a. Provide flashing to direct water to the exterior where it is likely to penetrate components in the wall assembly, including, above window and door heads, beneath window and door sills, at roof/wall intersections, decks, abutments of lower walls with higher walls, above projecting features, at floor lines, and at the base of the wall.
   b. Air Leakage Prevention - provide continuity of the air barrier system at foundation, roof, windows, doors, and other penetrations through the wall with connecting and compatible air barrier components to minimize condensation and leakage caused by air movement.
   c. Vapor Diffusion and Condensation - perform a dew point analysis and/or dynamic hydrothermal modeling of the wall assembly to determine the potential for accumulation of moisture in the wall assembly by diffusion. Adjust insulation thickness and/or other wall assembly components accordingly to minimize risk. Avoid the use of vapor retarders on the interior side of the wall in warm, humid climates.

C. Impact Resistance

1. Provide ultra-high impact resistance of the EIFS to a minimum height of 6'-0" (1.8 m) above finished grade.

D. Color Selection

1. Select finish coat with a light reflectance value of 20 or greater. Refer to Section 090000, Color Schedule.

E. Joints

1. Provide minimum 3/4 inch (19 mm) wide joints in the EIFS where they exist in the substrate or supporting construction, where the cladding adjoins dissimilar construction or materials, at changes in building height, at expansion, control, and cold joints in construction, and at floor lines in multi-level wood frame construction. Size joints to correspond with anticipated movement. Align terminating edges of EIFS with joint edges of through wall expansion joints and similar joints in construction. Refer to Sto Details.
2. Provide minimum 1/2 inch (13 mm) wide perimeter sealant joints at all penetrations through the EIFS (windows, doors, mechanical, electrical, and plumbing penetrations, etc.).
3. Specify compatible backer rod and sealant that has been evaluated in accordance with ASTM C 1382, and that meets minimum 50% elongation after conditioning.
4. Provide joints so that air barrier continuity is maintained across the joint, and drain joints to the exterior, or provide other means to prevent or control water infiltration at joints.

F. Grade Condition

1. Do not extend the EIFS below grade. Provide minimum 6-inch (152 mm) clearance above grade or as required by code.

G. Trim, Projecting Architectural Features and Reveals

1. All trim and projecting architectural features must have a minimum 1:2 [27□] slope along their top surface.

H. Insulation Thickness

1. Minimum GPS insulation thickness is 1 ½ inch (37 mm).

1.5 PERFORMANCE REQUIREMENTS

A. Comply with ASTM E 2568, ASTM E 2570, and the requirements of the Basis-of-Design Product.

1.6 QUALITY ASSURANCE

A. Manufacturer Requirements

1. Member in good standing of the EIFS Industry Members Association (EIMA)
2. Air/moisture barrier and EIFS manufacturer for a minimum of thirty (30) years
3. Manufacturing facilities ISO 9001:2008 Certified Quality System and ISO 14001:2004 Certified Environmental Management System

B. Contractor Requirements

1. Engaged in application of similar systems for a minimum of three (3) years
2. Knowledgeable in the proper use and handling of Sto materials
3. Employ skilled mechanics who are experienced and knowledgeable in air/moisture barrier and EIFS application, and familiar with the requirements of

the specified work

4. Successful completion of minimum of three (3) projects of similar size and complexity to the specified project
5. Provide the proper equipment, manpower and supervision on the job site to install the system in compliance with Sto's published specifications and details and the project plans and specifications

C. Insulation Board Manufacturer Requirements

1. GPS (Graphite Polystyrene) board listed by an approved agency

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver all materials in their original sealed containers bearing manufacturer's name and identification of product

B. Protect coatings (pail products) from freezing and temperatures in excess of 90 degrees F (32 degrees C). Store away from direct sunlight.

C. Protect Portland cement-based materials (bag products) from moisture and humidity. Store under cover off the ground in a dry location.

1.8 PROJECT/SITE CONDITIONS

A. Maintain ambient and surface temperatures above 40 degrees F (4 degrees C) during application and drying period, minimum 24 hours after application of Air/Moisture barrier and EIFS products

B. Provide supplementary heat for installation in temperatures less than 40 degrees F (4 degrees C)

C. Provide protection of surrounding areas and adjacent surfaces from application of products

1.9 COORDINATION/SCHEDULING

A. Provide site grading such that the EIFS terminates above grade a minimum of 6 inches (150 mm) or as required by code

B. Coordinate installation of foundation waterproofing, roofing membrane, windows, doors and other wall penetrations to provide a continuously connected air and moisture barrier

C. Provide protection of rough openings before installing windows, doors, and other penetrations through the wall

D. Install window and door head flashing immediately after windows and doors are installed

E. Install diverter flashings wherever water can enter the wall assembly to direct water to the exterior

F. Install splices or tie-ins from air/moisture barrier over back leg of flashings, starter tracks, and similar details to form a shingle lap that directs incidental water to the exterior

G. Install copings and sealant immediately after installation of the EIFS when coatings are dry, and such that, where sealant is applied against the EIFS surface, it is applied

against the base coat or primed base coat surface

H. Schedule work such that air/moisture barrier is exposed to weather no longer than 30 days if Sto Gold Coat is used.

I. Attach penetrations through the EIFS to structural support and provide water tight seal at penetrations

1.10 WARRANTY

A. Provide manufacturer's warranty stating the system will be warranted against defects of all constituent products and as a system for a minimum of ten years from date of Acceptance by Owner.

B. Provide an installer warranty against defective workmanship for a period of two years from date of Acceptance by Owner.

C. Warranties shall be non-prorated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Provide Air/Moisture Barrier and EIFS coatings and accessories from single source manufacturer or approved supplier

B. Subject to the requirements of this spec, including but not limited to the contact angle of water adhesion exhibited and documented for the Basis-of-Design product (125 degrees), the following are acceptable manufacturers:

1. Sto Corp. (Basis-of-Design System: StoTherm ci Lotusan)
2. Dryvit
3. Parex

2.2 AIR/MOISTURE BARRIER

A. StoGuard®

1. Joint Treatment, Rough Opening Protection, and Detail Components:

a. Sto Gold Coat® - ready mixed coating applied by brush, roller or spray for rough opening protection of frame walls and joint treatment of sheathing when used with StoGuard Fabric. Also used as a detail component with StoGuard Fabric to splice over back flange of starter track, flashing, and similar ship lap details

2. Waterproof Coating:

a. Sto Gold Coat® - ready mixed waterproof coating for concrete, concrete masonry, wood-based sheathing, and glass mat gypsum sheathing

2.3 ADHESIVE

A. Sto TurboStick™ - one component polyurethane spray foam adhesive

2.4 INSULATION BOARD

A. GPS graphite expanded polystyrene rigid foam plastic insulation board; 2-inch thickness.

2.5 BASE COAT

A. Sto BTS® Xtra - one component polymer modified cement based high build base coat for insulation board. Also used as a leveler for concrete and masonry surfaces

B. Waterproof Base Coat

1. Sto Watertight Coat – pre-packaged two component fiber reinforced acrylic based waterproof base coat (for use as a waterproof base coat over Sto BTS Xtra for foundations, parapets, splash areas, trim and other projecting architectural features)

2.6 REINFORCING MESHES

A. Standard Mesh

1. Sto Mesh - nominal 4.5 oz/yd^2(153 g/m^2), symmetrical, interlaced open-weave glass fiber fabric made with alkaline resistant coating for compatibility with Sto materials.
2. Sto Intermediate Mesh - nominal 11.2 oz./yd^2 (380 g/m^2), high impact, interwoven, open weave glass fiber fabric with alkaline resistant coating for compatibility with Sto materials.
3. Ultra-High Impact Mesh - Sto Armor Mat - nominal 15 oz/yd2 (509 g/m2), ultra-high impact, double strand, interwoven, open-weave glass fiber fabric with alkaline resistant coating for compatibility with Sto materials

2.7 FINISH COAT

A. Stolit Lotusan - acrylic based Bio-mimicry engineered, not silicone enhanced textured wall finish with graded marble aggregate and self- cleaning properties. Finish texture: Limestone.

2.8 JOB MIXED INGREDIENTS

A. Water - clean and potable

B. Portland cement - Type I, Type II, or Type I-II in conformance with ASTM C 150

2.9 ACCESSORIES

A. Starter Track – rigid PVC (polyvinyl chloride) plastic track Part No. STDE as furnished by Plastic Components, Inc., 9051 NW 97th Terrace, Miami, FL 33178 (800 327 – 7077).

B. Sto-Mesh Corner Bead Standard – one component PVC (polyvinyl chloride) accessory with integral reinforcing mesh for outside corner reinforcement.

C. Sto Drip Edge Profile - one component PVC (polyvinyl chloride) accessory with integral reinforcing mesh that creates a drip edge and plaster return

2.10 MIXING

A. Sto Gold Coat - mix with a clean, rust-free high-speed mixer to a uniform consistency

B. Sto BTS Xtra - mix ratio with water: 4.75- 5 quarts (4.5-4.7 L) of clean potable water per 38-pound (17.2 kg) bag of Sto BTS Xtra. Pour water into a clean mixing pail. Add Sto BTS Xtra, mix to a uniform consistency and allow to set for approximately 5 minutes. Adjust mix if necessary, with additional Sto BTS Xtra or water and remix to a uniform trowel consistency. Avoid retempering. Keep mix ratio consistent. Do not exceed maximum amount of water in mix ratio.

C. Sto Watertight Coat – pour liquid component into a clean mixing pail. Add dry component, mix to a uniform consistency and allow to set for approximately five minutes. Adjust mix if necessary and remix to a uniform trowel consistency. Avoid retempering. Keep mix ratio consistent.

D. Sto primer - mix with a clean, rust-free high-speed mixer to a uniform consistency

E. Stolit Lotusan - mix with a clean, rust-free high-speed mixer to a uniform consistency. A small amount of water may be added to adjust workability. Limit addition of water to amount needed to achieve the finish texture.

F. Mix only as much material as can readily be used

G. Do not use anti-freeze compounds or other additives

PART 3 - EXECUTION

3.1 EXAMINATION

A. Inspect concrete and masonry substrates prior to start of application for:

1. Contamination—algae, chalkiness, dirt, dust, efflorescence, form oil, fungus, grease, laitance, mildew or other foreign substances
2. Surface absorption and chalkiness
3. Cracks—measure crack width and record location of cracks
4. Damage and deterioration such as voids, honeycombs and spalls
5. Moisture content and moisture damage—use a moisture meter to determine if the surface is dry enough to receive the products and record any areas of moisture damage
6. Compliance with specification tolerances—record areas that are out of tolerance (greater than ¼ inch in 8-0 feet [6mm in 2438 mm] deviation in plane)

B. Inspect sheathing application for compliance with applicable requirement and installation in conformance with specification and manufacturer requirements:

1. Glass Mat Faced gypsum sheathing compliant with ASTM C 1177
2. Attachment into structural supports with adjoining sheets abutted and fasteners at required spacing to resist design wind pressures as determined by design professional
3. Fasteners seated flush with sheathing surface and not over-driven

C. Report deviations from the requirements of project specifications or other conditions that might adversely affect the Air/Moisture Barrier and the EIFS installation to the General Contractor. Do not start work until deviations are corrected.

3.2 SURFACE PREPARATION

A. Remove surface contaminants on concrete, concrete masonry, gypsum sheathing, or coated gypsum sheathing surfaces

B. Repair cracks, spalls or damage in concrete and concrete masonry surfaces and level concrete and masonry surfaces to comply with required tolerances

C. Apply conditioner (consult Sto) by spray or roller to chalking or excessively absorptive surfaces or pressure wash to remove surface chalkiness

D. Remove fasteners that are not anchored into supporting construction and seal holes with air barrier material

E. Seal over-driven fasteners with air barrier material and install additional fasteners as needed to comply with fastener spacing requirement

F. Fill large gaps between sheathing or voids around pipe, conduit, scupper, and similar penetrations with spray foam and shave flush with surface

G. Replace weather-damaged sheathing and repair or replace damaged or cracked sheathing

3.3 INSTALLATION

A. Air/Moisture Barrier Installation over Glass Mat Faced Gypsum Sheathing in Compliance with ASTM C 1177.

B. Transition Detailing

1. Detail transition areas with Sto RapidGuard or StoGuard Transition Membrane to achieve air barrier continuity. For illustrations of installation, refer to Sto guide Details and Sto RapidGuard Installation Guide or StoGuard Transition Membrane Installation Guide (www.stocorp.com)

C. Rough Opening Protection

1. Sto Gold Coat with StoGuard Fabric: apply coating liberally by spray or roller to corners of openings, immediately place StoGuard RediCorners in the wet coating, and apply additional coating over the RediCorners to completely embed them. After all corners have been completed apply coating liberally to the entire rough opening, immediately place StoGuard Fabric in the wet coating, smooth any wrinkles with a brush or roller, and apply additional coating over the fabric to completely embed it. Overlap all seams minimum 2 inches (51 mm). Once completed top coat with additional coating as needed to completely seal the surface. Allow to dry and inspect for pinholes or voids. If pinholes or voids are present, seal with additional coating or StoGuard RapidSeal

D. Sheathing Joint Treatment

1. Sto Gold Coat or Sto AirSeal with StoGuard Fabric: apply coating liberally by spray or roller along sheathing joints and immediately place 4 inch (102 mm) wide fabric centered over the joints into the wet coating, and 6 inch (152 mm) wide fabric centered and folded at inside and outside corners into the wet coating. Smooth any wrinkles with a brush or roller and apply additional coating to completely embed the fabric. Overlap seams minimum 2 inches (51 mm).

E. Air/Moisture Barrier Coating Installation

1. Gypsum Sheathing: apply waterproof coating by spray or roller over sheathing surface, including the dry joint treatment, rough opening protection, and transition areas, to a uniform wet mil thickness of 10 mils in one coat (Sto Gold Coat). Use ¾ inch (19 mm) nap roller for glass mat faced gypsum sheathing. Protect from weather until dry.

F. Air /Moisture Barrier Connections and Shingle Laps

1. Coordinate installation of connecting air barrier components with other trades to provide a continuous air tight membrane.
2. Coordinate installation of flashing and other moisture protection components with other trades to achieve complete moisture protection such that water is directed to the exterior, not into the wall assembly, and drained to the exterior at sources of leaks (windows, doors and similar penetrations through the wall assembly).
3. Splice-in head flashings above windows, doors, floor lines, roof/sidewall step flashing, and similar locations with StoGuard detail component to achieve shingle lap of the air/moisture barrier such that water is directed to the exterior.

3.5 EIFS Installation

A. Starter Track

1. Strike a level line at the base of the wall to mark where the top of the starter track terminates.
2. Attach the starter track even with the line into structural supports with the proper fastener: Type S-12 corrosion resistant screws for steel framing with minimum 3/8 inch (9 mm) and three thread penetration Attach between studs into blocking as needed to secure the track flat against the wall surface. Attach at maximum 16 inches (406 mm) on center into framing. For concrete/masonry surfaces, attach directly at 12 inches (305 mm) on center maximum.
3. Butt sections of starter track together. Miter cut outside corners and abut. Snip front flange of one inside corner piece (to allow XPS insulation board to be seated inside of track) and abut.
4. Install Starter Track at other EIFS terminations as designated on detail drawings: above roof along dormers or gable end walls, and beneath window sills with concealed flashing.

B. Detail Splice Strips for Starter Track, Flashing at Floor Lines, Head of Windows and Doors

1. Starter Track, Window/Door Head Flashing, Floor Line Flashing, and Roof/Side Wall Step Flashing: Install minimum 4 inch (100 mm) wide detail component over back flange of starter track, floor line flashing, head flashing, and roof/side wall step flashing.
   Center the detail component so it spans evenly between the back leg of flashing (or accessory) and the coated sheathing. Make a smooth transition to the coated sheathing with a trowel, knife, or roller, depending on the detail component material being used.

C. Back wrapping

1. Apply a strip of detail mesh to the dry air/moisture barrier at all system terminations (windows, doors, expansion joints, etc.) except where the Starter Track is installed. The mesh must be wide enough to adhere approximately 4 inches (100 mm) of

mesh onto the wall, be able to wrap around the insulation board edge and cover a minimum of 2 ½ inches (64 mm) on the outside surface of the insulation board. Attach mesh strips to the air/moisture barrier and allow them to dangle until the back-wrap procedure is completed. Alternatively, pre-wrap terminating edges of insulation board.

D. Adhesive Application and Installation of Insulation Board

1. Ensure the air/moisture barrier surface (Sto Gold Coat) is free of surface contamination. Install the insulation board within 30 days of the application of the air/moisture barrier coating (Sto Gold Coat), or clean the surface and recoat with Sto Gold Coat.
2. Cut the insulation board squarely to a 2 x 4-foot (0.6 x 1.2 m) dimension (if not already furnished pre-cut).
3. Rasp the interior lower face of insulation boards to provide a snug friction fit into the Starter Track.
4. Apply adhesive to the back of the insulation board with the dispensing pistol approximately ¾ inch (19 mm) from ends. Apply 6 additional ribbons spaced equally at no greater than 5-6 inches (127-152 mm) apart between the end ribbons for a total of 8 ribbons. Apply uniform ribbons of adhesive parallel with the SHORT dimension of the board so that when boards are placed on the wall the ribbons will be VERTICAL. Apply adhesive ribbons approximately ½ inch (51 mm) in diameter which will expand to ¾ - 1 inch (19 – 25 mm). Keep adhesive ½ inch (51 mm) short of board edges. Apply adhesive uniformly so ribbons of adhesive do not converge. Allow adhesive to “dwell” and become “tacky” before placing boards on wall. Adhesive will look smooth, not jagged, when ready to apply to wall surface. Place boards while adhesive is “tacky” and before adhesive “skins”.
5. Place insulation boards in a running bond pattern on the wall with the long dimension horizontal. Start by inserting the lower edge of the boards inside the starter track at the base of the wall until they contact the bottom of the track. Apply light pressure when placing the boards. After boards have been in place for 5-10 minutes use a straight edge to lightly press the boards inward and to keep board joints flush, as post expansion of the adhesive may force boards slightly outward.
6. Bridge sheathing joints by a minimum of 6 inches (152 mm). Interlock inside and outside corners.
7. Butt all board joints tightly together to eliminate any thermal breaks. Care must be taken to prevent any adhesive from getting between the joints of the boards.
8. Cut insulation board in an L-shaped pattern to fit around openings. Do not align board joints with corners of openings.
9. Check for satisfactory contact of the insulation board with the substrate. If any boards have loose areas use the dispensing pistol to create a hole through the board and inject adhesive to attach the loose area. Allow the adhesive to expand to the outer face of the board while withdrawing the pistol. Cut excess adhesive flush with the surface of the insulation. Do not use nails, screws, or any other type of non-thermal mechanical fastener.

E. Slivering and Rasping of Insulation Board Surface

1. Make sure insulation boards are fully adhered to the substrate before proceeding.
2. Fill any open joints in the insulation board layer with slivers of insulation or the spray foam adhesive.
3. Rasp the insulation board surface to achieve a smooth, even surface and to remove any ultraviolet ray damage.

F. Completion of Back wrapping

1. Complete the back-wrapping procedure by applying base coat to exposed edges of insulation board and approximately 4 inches (100 mm) onto the face of the insulation board. Pull mesh tight around the board and embed it in the base coat with a stainless-steel trowel. Use a corner trowel for clean, straight lines. Smooth any wrinkles or gaps in the mesh.

G. Accessory Installation

1. Corner Bead: cut the corner bead accessory to proper length as needed. Use full pieces wherever possible and avoid using short filler pieces. Offset accessory butt joints from substrate joints. Apply base coat with a stainless-steel trowel to an approximate thickness of 1/8 inch (3 mm) to the outside corner area that will receive the accessory. Immediately place the accessory directly into the wet base coat material. Do not slide into place. Press the accessory into place. A corner trowel is best for this purpose. Embed and completely cover the mesh and PVC by troweling from the corner to the edge of the mesh so that no mesh or PVC color is visible. Avoid excess build-up of base coat and feather along mesh edges. Adjoin separate pieces by abutting PVC to PVC and overlapping the mesh “tail” from one piece onto the next piece. Fully embed the accessory and mesh “tail” in base coat material. When installing field mesh reinforcement overlap accessory mesh minimum and PVC. Remove any excess base coat from the outside corner.
2. Drip Edge: install the drip edge accessory prior to application of field mesh. Install with arrow on mesh pointing UP. Cut the accessory to proper length as needed. Use full pieces wherever possible and avoid using short filler pieces. Offset accessory butt joints from substrate joints. Apply base coat with a stainless-steel trowel to an approximate thickness of 1/8 inch (3 mm) to the area that will receive the accessory. Immediately place the accessory directly into the wet base coat material and press into place. Do not slide into place. Embed and completely cover the mesh and PVC by troweling from the drip edge screed rail to the edge of the mesh. Avoid excess build-up of base coat, feather along mesh edges, and remove any excess base coat from the drip edge nosing. Abut adjoining pieces and install as described above. When installing field mesh reinforcement overlap accessory mesh 4 inches (10 cm) on both vertical and horizontal faces so the PVC is overlapped, and remove any excess base coat from the drip edge nosing. On vertical and horizontal faces of the accessory install finish to the drip edge lines and remove any protruding finish from the drip edge nosing.

H. Base Coat and Reinforcing Mesh Application

1. Ensure the insulation board is firmly adhered and free of surface contamination or UV degradation, and is thoroughly rasped before commencing the base coat application.
2. Apply minimum 9x12 inch (225x300 mm) diagonal strips of detail mesh at corners of windows, doors, and all penetrations through the system. Embed the strips in wet base coat and trowel from the center to the edges of the mesh to avoid wrinkles.
3. Apply detail mesh at trim, reveals and projecting architectural features. Embed the mesh in the wet base coat. Trowel from the base of reveals to the edges of the mesh.
4. Ultra-High impact mesh application (recommended to a minimum height of 6’-0" [1.8 m] above finished grade at all areas accessible to pedestrian traffic and other

areas exposed to abnormal stress or impact, and where indicated on contract drawings): apply base coat over the insulation board with a stainless-steel trowel to a uniform thickness of approximately 1/8 inch (3 mm). Work horizontally or vertically in strips of 40 inches (1016 mm), and immediately embed the mesh into the wet base coat by troweling from the center to the edge of the mesh. Butt ultra-high impact mesh at seams. Allow the base coat to dry.

5. Standard mesh application: Apply base coat over the insulation board, including areas with Ultra-High impact mesh, with a stainless-steel trowel to a uniform thickness of approximately ⅛ inch (3 mm). Work horizontally or vertically in strips of 40 inches (1016mm), and immediately embed the mesh into the wet base coat by troweling from the center to the edge of the mesh. Overlap mesh not less than 2-½ inches (64 mm) at mesh seams and at overlaps of detail mesh. Feather seams and edges. Double wrap all inside and outside corners with minimum 6 inch (152 mm) overlap in each direction. Avoid wrinkles in the mesh. The mesh must be fully embedded so that no mesh color shows through the base coat when it is dry. Re-skim with additional base coat if mesh color is visible.
6. Sloped Surfaces: for trim, reveals, aesthetic bands, cornice profiles, sills or other architectural features that project beyond the vertical wall plane more than 2 inches (51 mm) apply waterproof base coat with a stainless-steel trowel to the sloped surface and minimum four inches (100 mm) above and below it. Embed standard mesh or detail mesh in the waterproof base coat and overlap mesh seams a minimum of 2-½ inches (65 mm).
7. Allow base coat to thoroughly dry before applying primer or finish.

I. Finish Coat Application

1. Ensure the base coat surface or primed base coat is free of surface contamination before commencing the finish application.
2. Apply finish directly over the base coat or primed base coat when dry. Apply finish by spray or stainless-steel trowel, depending on the finish specified. Follow these general rules for application of finish:
   a. Avoid application in direct sunlight.
   b. Apply finish in a continuous application, and work to an architectural break in the wall.
   c. Weather conditions affect application and drying time. Hot or dry conditions limit working time and accelerate drying. Adjustments in the scheduling of work may be required to achieve desired results. Cool or damp conditions extend working time and retard drying and may require added measures of protection against wind, dust, dirt, rain and freezing. Adjust work schedule and provide protection.
   d. Do not install separate batches of finish side-by-side.
   e. Do not apply finish into or over sealant joints. Apply finish to outside face of wall only.
   f. Do not apply finish over irregular or unprepared surfaces, or surfaces not in compliance with the requirements of the project specifications.

3.6 EXTERIOR SOFFITS

A. Apply Sto Gold Coat with Base Coat and Reinforcing Mesh onto glass matt sheathing. Apply finish directly over the base coat or primed base coat when dry.

3.7 PROTECTION

A. Provide protection of installed materials from water infiltration into or behind them

B. Provide protection of installed materials from dust, dirt, precipitation, freezing and continuous high humidity until they are fully dry

3.8 CLEANING, REPAIR AND MAINTENANCE

A. Clean and maintain the EIFS for a fresh appearance and to prevent water entry into and behind the system. Repair cracks, impact damage, spalls or delamination promptly.

B. Maintain adjacent components of construction such as sealants, windows, doors, and flashing, to prevent water entry into or behind the EIFS and anywhere into the wall assembly

C. Refer to Sto reStore Repair and Maintenance Guide (reStore Program) for detailed information on restoration - cleaning, repairs, recoating, resurfacing and refinishing, or re-cladding

END OF SECTION 072419

SECTION 075423 - THERMOPLASTIC POLYOLEFIN (TPO) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fully Adhered TPO membrane roofing system.
2. Roof drain.
3. Walkway pads.

B. Related Sections:

061000	Rough Carpentry
072100	Thermal Insulation
072726	Fluid Applied Membrane Air Barriers
076200	Sheet Metal Flashing & Trim
079200	Joint Sealants

1.2 PERFORMANCE REQUIREMENTS

A. Solar Reflectance Index: Not less than 78 when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

B. Energy Performance: Provide roofing system that is listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.

1.3 PRE-INSTALLATION CONFERENCE

A. Prior to installation commencement of the roofing installation and associated work, conduct a meeting at the project site with the installer, architect, owner, GAF representative and any other persons directly involved with the performance of the work. The installer shall record conference discussions to include decisions and agreements reached (or disagreements), and furnish copies of recorded discussions to each attending party. The main purpose of this meeting is to review foreseeable methods and procedures related to roofing work.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.

C. Samples for Verification: For the following products:

1. White Sheet roofing.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product.

B. Source Limitations: Obtain components including roof insulation adhesive and fasteners for membrane roofing system from same manufacturer as membrane roofing or approved by membrane roofing manufacturer.

C. Exterior Fire-Test Exposure: ASTM E 108, Class C; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.

1.7 WARRANTIES

A. Manufacturer's Guarantee: Manufacturer's standard form, non-pro-rated, without monetary limitation or deductibles, in which manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period. Failure includes roof leaks or breaches in the primary roof membrane causing moisture to enter the substrate below (even if visible leaks are not observed inside the facility).

1. Warranty to include but not be limited to membrane, insulation, adhesives, fasteners, sealants, flashings, polymer clad sheet metal, etc.
2. Warranty Period: Twenty years from date of Final Acceptance.
3. Warranty to remain in effect for wind speeds up to 72 mph.
4. Warranties requiring the Owner's signature are not acceptable.

B. Contractor's Warranty:

1. Two Year Warranty: Manufacturer's Representative and Contractor's Representative will attend post construction field inspection no earlier than one month prior to the expiration date of the Contractor's Warranty. Submit a written report within seven (7) days of the site visit to the Engineer listing observations, conditions and recommended repairs or remedial action.

PART 2 - PRODUCTS

2.1 TPO MEMBRANE ROOFING

B. Fabric-Reinforced Thermoplastic Polyolefin Sheet: ASTM D 6878, internally fabric or scrim reinforced, uniform, flexible fabric backed TPO sheet.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. GAF Materials Corporation. <u>Everguard Fleece-Back</u> is Basis of Design.
b. Carlisle SynTec Incorporated.
c. Sike Sarnafil.

2. Thickness: 60 mils (1.45 mm), nominal.

3. Membrane color: White.

2.2 AUXILIARY MEMBRANE ROOFING MATERIALS

A. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use, and compatible with membrane roofing.

1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.

2. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

   a. Plastic Foam Adhesives: 50 g/L.
   b. Gypsum Board and Panel Adhesives: 50 g/L.
   c. Multipurpose Construction Adhesives: 70 g/L.
   d. Fiberglass Adhesives: 80 g/L.
   e. Single-Ply Roof Membrane Adhesives: 250 g/L.
   f. Other Adhesives: 250 g/L.
   g. Single-Ply Roof Membrane Sealants: 450 g/L.
   h. Non-membrane Roof Sealants: 300 g/L.
   i. Sealant Primers for Nonporous Substrates: 250 g/L.
   j. Sealant Primers for Porous Substrates: 775 g/L.

B. Sheet Flashing: Manufacturer's standard unreinforced thermoplastic polyolefin sheet flashing, 55 mils (1.4 mm) thick, minimum, of same color as sheet membrane.

C. Bonding Adhesive: Manufacturer's standard.

D. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.

E. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick (25 mm wide by 1.3 mm thick), pre-punched.

F. Concrete and Masonry Flashing Membrane Termination Anchors:

1. ¼-nch diameter metal-based expansion anchor with stainless steel pin of length to penetrate substrate a minimum of 1-1/2 inch.
2. Masonry screws approved my membrane manufacturer, 1/4 inch minimum diameter, corrosion resistant, with Phillips flat head. Length to provide minimum 1 ½ -inch embedment into substrate.

G. Solid Concrete Deck Fasteners and Plates:

1. #14 corrosion-resistant fastener used with approved plates for membrane attachment with shank diameter of 0.190 inch, a thread diameter of 0.245 inch and a #3 Phillips drive head with a diameter of 0.435 inch.
2. Nail-in, non-threaded fasteners with split bulb tip designed for securement of membrane and insulation to structural concrete roof decks, length to penetrate deck a minimum of 1" with plates as approved by roof membrane manufacturer.

H. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer.

I. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

2.3 ROOF INSULATION AND CANTS OR CRICKETS – TAPERED POLYISOCYANURATE OR MINERAL BASED

A. Material for cants or crickets shall be acceptable to the roofing manufacturer.

2.5 ROOF DRAINS

A. Provide Zurn Z-100 roof drain assembly or equivalent by Wade or Josam.

1. Sizes to meet requirements of roof drain leaders on the Drawings.

2.6 CURBS, PIPE BOOTS, ETC.

A. Provide items as required to complete the installation and protect all equipment and pipe penetrations.

2.7 WALKWAY PAD

A. Walkway Pad is a roll measuring 34" x 50' (864 mm x 15.24 m), and has a diamond pattern measuring 30" (762 mm) with 2” smooth sides for welding. Rolls are made of recycled TPO and “Everguard” or equivalent product, are 125-mil thickness and are in standard gray. Provide in areas shown on Sheet A3.3.

PART 3 - EXECUTION

3.1 INSULATION INSTALLATION

A. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.

C. Provide continuous insulation sleeve for roof drains and piping that occur over tempered portions of the building. Refer to Plumbing Insulation Specification for type and thickness.

D. Install crickets at the high side of all obstructions (mechanical equipment, roof hatches, skylights, etc.) to assure water does not pond in these locations.

3.2 MEMBRANE INSTALLATION (ADHERED)

A. Over the properly installed and prepared substrate, spread membrane adhesive in accordance with the manufacturer's instructions and application rates utilizing equipment as required by the manufacturer.

1. Do not allow adhesive to skin-over or surface-dry prior to installation of roof membrane.
2. Do not utilize water based membrane adhesive if temperatures below 40º F (5º C) are expected during application or subsequent drying time.
3. Comply with the manufacturer's published requirements for adhesive application rates.
4. Count the amount of pails of adhesive used per area per day to verify conformance to the specified adhesive rate.
5. Do not apply adhesive in seam areas.
6. Replace notched squeegees daily or as notches are reduced below 1/4 inch.

B. Place roof membrane into the adhesive in accordance with manufacturer's instructions.

C. Shingle seams with flow of water. Overlap upslope, adjacent rolls 3 inches over previous roll. This process is repeated throughout the roof area.

D. After placement of membrane, press roll into place with the manufacturer's recommended roller by frequent rolling in two directions.

E. Weld membrane cover strips at fleeceback membrane seams without a factory selvage edge.

3.4 MEMBRANE TERMINATION

A. Terminate membrane at walls and curbs as shown in the contract drawings.

1. Roof Deck: Mechanically terminated using specified fasteners and plates 6 inches on center.
2. Wood Wall Substrate: Turn membrane up wall 1 inch and mechanically terminate using specified screws 8 inches on center with a termination bar.
3. Concrete/Masonry Wall Substrate: Turn membrane up wall 1 inch and mechanically terminated using specified anchors 8 inches on center with a termination bar.

B. Terminate membrane at penetrations as shown in the contract drawings.

1. Fasten membrane 6 inches on center or a minimum of 4 fasteners per penetration into the structural deck using fasteners and plates as approved by the membrane manufacturer for the deck substrate.

C. Extend membrane over roof edge a minimum of 2 inches below the perimeter wood blocking. If fleeceback membrane is utilized, trim membrane flush with outside edge of roof and hot-air weld a non fleeceback flashing membrane to extend over the roof edge.

3.3 BASE FLASHING INSTALLATION

A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars a minimum of 8-inches above roofing surface and as shown on the drawings.

F. At expansion joints, extend flashing membrane over joint and dip into cavity to allow for expansion.

G. Roof Drain:

1. Mechanically attach membrane 6 inches on center into structural deck around drain sump. Adhere flashing membrane and hot-air weld to membrane a minimum of 4 inches.

2. Set flashing membrane in bed of sealant under the clamping ring.

H. Soil Pipe/Pipe Penetration:

1. Provide field wrapped pipe penetration flashing or manufacturer's prefabricated pipe boot as shown in detail drawing.
2. Apply aluminum tape to penetration if asphalt contamination is present.
3. Hot-air weld horizontal flashing membrane a minimum of four inches onto the membrane.
4. Adhere vertical flashing membrane adhered to pipe penetration and extend a minimum of 1.5 inches horizontal at the base of penetration. Hot-air weld vertical flashing membrane to horizontal flashing membrane.
5. Install stainless steel draw band and sealant or hot-air weld flashing cap to terminate top edge of pipe flashing.

3.4 TRAFFIC PROTECTION

A. Install walkway pads at all roof access locations and other designated locations including roof-mounted equipment work locations and areas of repeated rooftop traffic.

B. Walkway rolls or pads must be spaced 6" (152 mm) apart to allow for drainage between the pads.

C. Heat-weld walkway rolls or pads to the roof membrane surface continuously around the perimeter of the pad/roll.

3.5 FIELD QUALITY CONTROL

A Final Roof Inspection: Arrange for roofing system manufacturer’s technical personnel to inspect roofing installation on completion and provide the written inspection report to the Architect.

B. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements.

END OF SECTION 075423

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Formed receivers with counterflashing.
2. Formed roof-drainage sheet metal fabrications.
3. Formed roof edge trim.

B. Related Sections:

1. 033000, Cast-in Place Concrete.
2. 075422, Thermoplastic Polyolefin Roofing.
3. 074219, Water Drainage Exterior Insulation and Finish System (EIFS).
4. 084113, Aluminum-Framed Entrances and Storefronts.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For sheet metal flashing and trim.

1. Include plans, elevations, sections, and attachment details.
2. Distinguish between shop- and field-assembled work.
3. Include identification of finish for each item.
4. Include pattern of seams and details of termination points, expansion joints and expansion-joint covers, direction of expansion, roof-penetration flashing, and connections to adjoining work.

C. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

A. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

1.6 WARRANTY

A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Finish Warranty Period: 10 years from date of Acceptance by Owner.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. SPRI Wind Design Standard: Manufacture and install copings and roof edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressure:

1. Design Pressure: As indicated on Drawings.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 SHEET METALS

A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

1. Metallic-Coated Steel Sheet: Provide aluminum-zinc alloy-coated steel sheet according to ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation, Grade 40 (Grade 275); pre-painted by coil-coating process to comply with ASTM A 755/A 755M.
2. Surface: Manufacturer's standard clear acrylic coating on both sides.
3. Exposed Coil-Coated Finish:
4. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

B. Color: Match color shown in Section 090000 “Color Schedule”.

2.3 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design.

1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.

    1. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
    2. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
    3. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.

2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.

C. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, non-sag, nontoxic, non-staining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.

D. Elastomeric Sealant: ASTM C 920, elastomeric clear silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

E. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

F. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.

G. Bituminous Coating: Cold-applied asphalt emulsion according to ASTM D 1187.

H. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.4 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with details shown and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required. Fabricate sheet metal flashing and trim in shop to greatest extent possible.

1. Obtain field measurements for accurate fit before shop fabrication.
2. Form sheet metal flashing and trim to fit substrates without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
3. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.

1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with butyl sealant concealed within joints.
2. Use lapped expansion joints only where indicated on Drawings.

C. Sealant Joints: Where movable, non-expansion-type joints are required, form metal to provide for proper installation of elastomeric sealant according to cited sheet metal standard.

D. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

E. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard for application, but not less than thickness of metal being secured.

F. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints where necessary for strength.

2.5 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. All Exposed Flashing Except Roof Edge: Fabricate from the following materials:

1. Aluminum: 0.032 inch (0.81 mm) thick.

B. Roof Edge Coping Trim: Fabricate from the following materials:

1. Aluminum: 0.050 inch (1.27 mm) thick.

2.6 FASCIA AND SOFFIT SHEET METAL FABRICATIONS

A. All Exposed Flashing Except Roof Edge: Fabricate from the following materials:

1. Aluminum: 0.066 inch (1.68 mm) thick.

2.7 INSTALLATION, GENERAL

A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.

1. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
3. Space cleats not more than 12 inches (300 mm) apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
4. Install exposed sheet metal flashing and trim with limited oil canning, and free of buckling and tool marks.
5. Torch cutting of sheet metal flashing and trim is not permitted.

B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of 10 feet (3 m) with no joints within 24 inches (600 mm) of corner or intersection.

1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant concealed within joints.

D. Fasteners: Use fastener sizes that penetrate wood blocking or sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws.

E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

F. Seal joints as required for watertight construction. Prepare joints and apply sealants to comply with requirements herein and in Section 079200 "Joint Sealants."

G. Rivets: Rivet joints in aluminum where necessary for strength. Paint the exposed ends of the rivets to match the sheet metal finish.

2.8 ROOF FLASHING INSTALLATION

A. General: Install sheet metal flashing and trim to comply with performance requirements, and cited sheet metal standard. Provide concealed fasteners where possible, and set units true to line, levels, and slopes. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate.

C. Caps and Copings: Anchor to resist uplift and outward forces according to recommendations in cited sheet metal standard unless otherwise indicated.

D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches (100 mm) over base flashing. Install stainless-steel draw band and tighten.

E. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches (100 mm) over base flashing. Lap counterflashing joints minimum of 4 inches (100 mm).

F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with butyl sealant and clamp flashing to pipes that penetrate roof.

2.9 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder.

C. Clean off excess sealants.

D. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

END OF SECTION 076200

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Urethane joint sealants.
3. Latex joint sealants.
4. Preformed joint sealants.
5. Acoustical joint sealants.

B. Related Sections:

1. 033000, Cast-in-Place Concrete.
2. 042000, Unit Masonry.
3. 064023, Interior Architectural Woodwork.
4. 074100, Metal Wall Panel Rain Screen System.
5. 074219, Water Drainage Exterior Insulation and Finish System (EIFS).
6. 076200, Sheet Metal Flashing and Trim.
7. 081743, FRP Fire-Rated Frames.
8. 084113, Aluminum-Framed Entrances and Storefronts.
9. 088000, Glazing.
10. 092900, Gypsum Board.
11. 093000, Tiling.
12. 099123, Interior Painting.
13. 099600, High Performance Coatings.
14. Divisions 22, 23, 26, 28 (wall penetrations and fixtures abutting walls).

1.2 ACTION SUBMITTALS

A. Samples: For each kind and color of joint sealant required.

B. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Architectural Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

B. Low-Emitting Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Stain-Test-Response Characteristics: Where sealants are specified to be non-staining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

D. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.

2.2 SILICONE JOINT SEALANTS

A. Mildew-Resistant Neutral-Curing Silicone Joint Sealant: ASTM C 920.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. BASF Building Systems.
b. Dow Corning Corporation.
c. GE Advanced Materials - Silicones.
d. Pecora Corporation.
e. Tremco Incorporated.

2. Type: Single component (S).
3. Grade: Non-sag (NS).
4. Uses Related to Exposure: Nontraffic (NT).

2.3 URETHANE JOINT SEALANTS

A. Urethane Joint Sealant: ASTM C 920.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. BASF Building Systems.
b. Bostik, Inc.
c. Pecora Corporation.
d. Tremco Incorporated.

2. Type: Single component (S).
3. Grade: Non-sag (NS).
4. Uses Related to Exposure: Nontraffic (NT).

2.4 LATEX JOINT SEALANTS

A. Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. BASF Building Systems.
b. Bostik, Inc.
c. Pecora Corporation.
d. Tremco Incorporated.

2.5 ACOUSTICAL JOINT SEALANTS

A. Acoustical Joint Sealant: Manufacturer's standard non-sag, paintable, non-staining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Pecora Corporation .
b. USG Corporation.
c. Tremco Incorporated.

2.6 JOINT SEALANT BACKING

A. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

B. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer.

2.7 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials.

C. Masking Tape: Non-staining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

1. Remove laitance and form-release agents from concrete.
2. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.2 INSTALLATION

A. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

B. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

C. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Non-sag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.

F. Acoustical Sealant Installation: Comply with ASTM C 919 and with manufacturer's written recommendations.

G. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.3 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal non-traffic surfaces.

1. Joint Locations:

a. Construction joints in cast-in-place concrete.
b. Joints between plant-precast architectural concrete units.
c. Control and expansion joints in unit masonry.
d. Joints between different materials listed above.
e. Perimeter joints between materials listed above and frames of doors, windows and louvers.
f. Control and expansion joints in ceilings and other overhead surfaces.
g. All exterior joints between all dissimilar items, including between wall finish materials and Plumbing, Mechanical, Electrical and Fire Alarm Devices.

2. Joint Sealant: Urethane.
3. Joint-Sealant Color: Refer to Color Schedule 090000.

B. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal non-traffic surfaces.

1. Joint Locations:

a. Control and expansion joints on exposed interior surfaces of exterior walls.
b. Perimeter joints of exterior openings where indicated.
c. Tile control and expansion joints.

d. Vertical joints on exposed surfaces of interior unit masonry, walls and partitions.
e. Perimeter joints between interior wall surfaces and frames of interior doors, windows and storefront framing.
f. Other joints as indicated including between wall finish materials and Plumbing, Mechanical, Electrical and Fire Alarm Devices.

2. Joint Sealant: Latex.
3. Joint-Sealant: Color Refer to Color Schedule 090000.

C. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal non-traffic surfaces.

1. Joint Sealant Location:

a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
b. Tile control and expansion joints where indicated.
c. On the edges and behind the backsplashes of all millwork items (use clear sealant in these locations).
d. Other joints as indicated, including between wall finish materials and Plumbing, Mechanical, Electrical and Fire Alarm Devices.

2. Joint Sealant: Silicone.
3. Joint-Sealant Color: Refer to Color Schedule 090000.

D. Joint-Sealant Application: Interior acoustical joints in vertical surfaces and horizontal non-traffic surfaces.

1. Joint Location:

a. Acoustical joints where interior walls and partitions abut Tectum roof panels, interior aluminum frames and structural steel.

2. Joint Sealant: Acoustical.
3. Joint-Sealant Color: Match adjacent material color.

END OF SECTION 079200

SECTION 081416 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Solid-core doors with wood veneer faces.

B. Related Sections:

1. 081713, Fiberglass Fire-Rater Doors and Frames.
2. 084113, Aluminum-Framed Entrances and Storefronts.
3. 087100, Door Hardware.
4. 088000, Glazing.
5. 099123, Interior Painting.

1.2 QUALITY ASSURANCE

A. Quality Standard: In addition to requirements specified, comply with AWI's "Architectural Woodwork Quality Standards Illustrated" and WDMA I.S.1-A, "Architectural Wood Flush Doors."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of door.

B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; and the following:

1. Dimensions and locations of blocking.
2. Dimensions and locations of mortises and holes for hardware.
3. Dimensions and locations of cutouts.
4. Undercuts.
5. Requirements for veneer matching.
6. Doors to be factory finished and finish requirements.
7. Fire-protection ratings for fire-rated doors.

C. Samples: For factory-finished doors.

1.1 WARRANTY

A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Acceptance by Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Algoma Hardwoods, Inc.
2. Eggers Industries.
3. Graham; an Assa Abloy Group company.
4. Marshfield Door Systems, Inc.
5. Mohawk Flush Doors, Inc.; a Masonite company.
6. VT Industries Inc.

2.2 DOOR CONSTRUCTION, GENERAL

A. Low-Emitting Materials: Fabricate doors with adhesives and composite wood products that do not contain urea formaldehyde.

B. WDMA I.S.1-A Performance Grade:

1. Heavy Duty unless otherwise indicated.

C. Particleboard-Core Doors:

1. Particleboard: ANSI A208.1, Grade LD-2, made with binder containing no urea-formaldehyde resin.
2. Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware.

2.3 VENEER-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Solid-Core Doors

1. Grade: Custom, with Grade A faces.
2. Species: White Oak.
3. Cut: Quarter sawn.
4. Match between Veneer Leaves: Pleasing match.
5. Assembly of Veneer Leaves on Door Faces: Running match.
6. Core: Particleboard.
7. Construction: Five plies. Stiles and rails are bonded to core, and then entire unit is abrasive planed before veneering.

B. Provide MDO, painted doors where indicated, in lieu of transparent-finish veneer.

2.4 LIGHT FRAMES AND LOUVERS

A. Wood-Veneered Beads for Light Openings in Fire-Rated Doors: Manufacturer's standard wood-veneered noncombustible beads matching veneer species of door faces and approved for use in

doors of fire-protection rating indicated. Include concealed metal glazing clips where required for opening size and fire-protection rating indicated.

2.5 FABRICATION

A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.

1. Comply with NFPA 80 requirements for fire-rated doors.

B. Factory machine doors for hardware that is not surface applied.

C. Openings: Factory cut and trim openings through doors.

1. Light Openings: Trim openings with moldings of material and profile indicated.
2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 088000 "Glazing."

2.5 FACTORY FINISHING

A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.

1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.

B. Factory-finish doors that are indicated to receive transparent finish.

C. Transparent Finish:

1. Grade: Custom.
2. Finish: WDMA TR-6 catalyzed polyurethane.
3. Staining: Refer to Specification Section 090000.
4. Sheen: Satin.

PART 2 - EXECUTION

2.1 INSTALLATION

A. Hardware: For installation, see Section 087100 "Door Hardware." Installation Instructions: Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.

1. Install fire-rated doors according to NFPA 80.
2. Install smoke- and draft-control doors according to NFPA 105.

B. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.

1. Clearances: Provide 1/8 inch (3.2 mm) at heads, jambs, and between pairs of doors. Provide 1/8 inch (3.2 mm) from bottom of door to top of decorative floor finish or covering unless otherwise indicated. Where threshold is shown or scheduled, provide 1/4 inch (6.4 mm) from bottom of door to top of threshold unless otherwise indicated.

   a. Comply with NFPA 80 for fire-rated doors.

C. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

D. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

END OF SECTION 081416

SECTION 081743 – FIRE-RATED FRP DOORS AND FRAMES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. AF-222FR Sandstone Texture Fire-Rated Fiberglass Door installed in Fire-Rated Fiberglass Framing.

1.02 RELATED SECTIONS

A. Section 042000 – Masonry Mortar.
B. Section 055000 – Metal Fabrications.
C. Section 087100 – Door Hardware.
D. Section 088000 – Glazing.

1.03 REFERENCES

A. ASTM-D256 – Standard Test Methods for Determining the Pendulum Impact Resistance of Plastics.
B. ASTM-D570 – Standard Test Method for Water Absorption of Plastics.
C. ASTM-D638 – Standard Test Method for Tensile Properties of Plastics.
D. ASTM-D790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
E. ASTM-D2583 – Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
F. ASTM D2794 – Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
G. ASTM-D-4226 – Standard Test Methods for Impact Resistance of Rigid Poly(Vinyl Chloride) (PVC) Building Products
H. ASTM-E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
I. ASTM-G-53 - Standard Practice for Operating Light-and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials
J. CAN / ULC S104 – Standard Method for Fire Tests of Door Assemblies.
K. UL 10B – Standard for Fire Tests of Door Assemblies.
L. UL 10C – Standard for Positive Pressure Fire Tests of Door Assemblies.
M. NFPA 80 – Standard for Fire Doors and Other Opening Protectives.
N. NFPA 252 – Fire Tests of Door Assemblies.

1.04 SUBMITTALS

A. Must comply with Section 013300 – Submittal Procedures.
B. Action Submittals/ Informational Submittals.
    1. Product Data.
        a. Submit manufacturer’s product data sheets, catalog pages illustrating the products, description of materials, components, fabrication, finishes, installation instructions, and applicable test reports.
    2. Shop Drawings.
        a. Submit manufacturer’s shop drawings, including elevations, sections, and details indicating dimensions, tolerances, materials, fabrication, doors, panels, framing, hardware schedule, and finish.

3. Samples.

a. Submit manufacturer's door sample composed of door face sheet, core, framing and finish.
b. Submit manufacturer's sample of standard colors for door face and frame.

4. Testing and Evaluation Reports.

a. Submit testing reports and evaluations provided by manufacturer conducted by and accredited independent testing agency certifying doors and frames comply with specified performance requirements listed in Section 2.01 C.

5. Manufacturer Reports.

a. Manufacturer's Project References.

1. Submit list of successfully completed projects including project name, location, name of architect, type, and quantity of doors manufactured.

C. Closeout Submittals.

1. Operation and Maintenance Manual.

a. Submit manufacturer's maintenance and cleaning instructions for doors and frames, including maintenance and operating instructions for hardware.

2. Warranty Documentation.

a. Submit manufacturer's standard warranty.

1.05 QUALITY ASSURANCE

A. Manufacturer's Qualifications.

1. Continuously engaged in manufacturing of doors of similar type to that specified, with a minimum of 25 years concurrent successful experience.
2. Door and frame components must be fabricated by same manufacturer.
3. Evidence of a documented complaint resolution quality management system.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery.

1. Deliver materials to site in manufacturer's original, unopened, containers and packaging.
2. Labels clearly identifying opening, door mark, and manufacturer.

B. Storage.

1. Store materials in a clean, dry area, indoors in accordance with manufacturer's instructions.

C. Handling.

1. *Protect materials and finish from damage during handling and installation.*

1.07 WARRANTY

A. Warrant doors, frames, and factory installed hardware against failure in materials and workmanship, including excessive deflection, faulty operation, defects in hardware installation, and deterioration of finish or construction in excess of normal weathering.

B. Standard Period.

1. Ten years starting on date of shipment.

C. Limited lifetime

1. Covers failure of corner joinery, core deterioration, and delamination or bubbling of door skin and corrosion of all-fiberglass products while the door is in its specified application in its original installation.

D. Finish

1. SpecLite3® face sheets 10 years from Acceptance of the Project by the Owner.
2. Painted AF-220FR: 3 years after acceptance.
3. Painted FR frames: 3 years after acceptance.

PART 2 - PRODUCTS

2.01 FRP FIRE-RATED DOORS

A. Manufacturer (Basis of Design).

1. Special-Lite, Inc.
   a. PO Box 6, Decatur, Michigan 49045.
   b. Toll Free (800) 821-6531, Phone (269) 423-7068, Fax (800) 423-7610.
   c. Web Site www.special-lite.com.
   d. E-Mail info@special-lite.com.

B. Subject to the Requirements of this Specification, the following manufacturers are acceptable:

1. FRP Architectural Doors, Inc., Bensalem, PA.
2. CORRIM Company, Oshkosh, WI.

2.02 FRP FIRE-RATED FRAMES

A. Framing

1. FR-Series Framing
   a. Materials.
      1. ¼" thick, solid, pultruded, FRP profiles.
      2. No corrosive components or reinforcements.
      3. Solid tectonite filler.
      4. No steel or aluminum filler is allowed.
   b. Perimeter Frame Members.
      1. Factory fabricated.
      2. Integral 5/8" x 2-1/4" doorstop.
      3. Mitered with 4" x 4" x 3/8" pultruded FRP angle reinforcement with interlocking pultruded FRP brackets.
      4. 5-3/4", 6-3/4", 7-3/4", or 8-3/4" jamb depth.
      5. 2" face on jambs.
      6. 2" or 4" face on header.
      7. Knocked down for field assembly.
   c. Anchors
      1. Factory furnished as specified by drawings.
      2. Drywall tuck available.

2.03 PERFORMANCE

A. Face Sheet.

1. Standard Interior and Exterior Class C 0.120" thick, Sandstone texture, through color FRP sheet.
   a. Flexural Strength, ASTM-D790: 27 x 10^3 psi.

b. Flexural Modulus, ASTM-D790: 0.7 x 10^6 psi.
c. Tensile Strength, ASTM-D638: 18 x 10^3 psi.
d. Tensile Modulus, ASTM-D638: 1.0 x 10^6 psi.
e. Barcol Hardness, ASTM-D2583: 40.
f. Izod Impact, ASTM-D256: 7.0 ft-lb/in.
g. Gardner Impact Strength, ASTM-D5420: 30 in-lb.
h. Water Absorption, ASTM-D570: 0.16%/24hrs at 77°F.
i. Surface Burning, ASTM-E84: Flame Spread ≤ 200, Smoke Developed ≤ 450.
j. Chemical Resistance.

1. Excellent Rating.

a. Acetic Acid, Concentrated.
b. Acetic Acid, 5%.
c. Bleach Solution.
d. Detergent Solution.
e. Distilled Water.
f. Ethyl Acetate.
g. Formaldehyde.
h. Heptane.
i. Hydrochloric Acid, 10%.
j. Hydrogen Peroxide, 3%.
k. Isooctane.
l. Lactic Acid, 10%.

k. USDA/FSIS Requirements.

1. FRP face sheet with surfaseal is a finished outer surface material that is rigid; durable; non-toxic; non-corrosive; moisture resistant; a light, solid color such as white; easily inspected; smooth or an easily cleaned texture.
2. FRP face sheet with surfaseal does not contain any known carcinogen, mutagen, or teratogen classified as hazardous substances; heavy metals or toxic substances; antimicrobials; pesticides or substances with pesticidal characteristics.

B. Door Assembly.

1. 60 min pp category A door.
2. 90 min pp category B door.
3. 90 min pp category A door.
4. Temperature rise @ 30 min, 250 °F when vision lites do not exceed 100 in².
5. Temperature rise @ 60 min, 450 °F max.

2.04 MATERIALS

A. Fiberglass.

1. See 2.02.A.2.e.
2. See 2.02.B.2.e.
3. See 2.02.C.2.e

B. Fasteners.

1. All exposed fasteners will have a finish to match material being fastened.
2. 410 stainless steel or other non-corrosive metal.
3. Must be compatible with items being fastened.

2.05 FABRICATION

A. Factory Assembly.

1. Door and frame components from the same manufacturer.
2. Required size for door and frame units, shall be as indicated on the drawings.
3. Maintain continuity of line and accurate relation of planes and angles.

4. Secure attachments and support at mechanical joints with hairline fit at contact surfaces.

B. Shop Fabrication

1. All shop fabrication to be completed in accordance with manufactures process work instructions.
2. Quality control to be performed before leaving each department.

2.06 FINISHES

A. Door.

1. FRP Face Sheets

a. Through color.

1. Color.

a. Choose an item.

B. Door Paint

1. Two-component flexible acrylic urethane Satin topcoat. (STANDARD)

a. Color.

1. Choose an item.

b. Custom colors available consult manufacturer.
c. Excellent exterior durability.
d. Unique, high-solids, high-build, multifunctional coating.
e. Low VOC, Satin coating.
f. Impact Resistance, ASTM D-4226 Minimum 1.2 in/lb/mil
g. Color retention: ≤1Δ (CIE L.a.b.), Montreal 45° South: 12 months
h. Very good chemical resistance.

2. Two-component acrylic urethane enamel Gloss topcoat. (OPTIONAL)

a. Color.
b. Custom colors available consult manufacturer.
c. Unique, high-solids, high-build, multifunctional coating.
d. Low VOC, Gloss coating.
e. Impact Resistance, ASTM-D2794: 80-102 in/lb (direct), 40-80 in/lb (reverse) @ 1.5 mils thickness.
f. Color retention: Δ E < 5 (CIE L.a.b.), Florida Exposure: 18 months
g. Excellent chemical resistance.

C. Frame

1. Fiberglass.
2. Two-component flexible acrylic urethane Satin topcoat. (STANDARD)

a. Color.
1. Choose an item.
b. Custom colors available consult manufacturer.
c. Excellent exterior durability.
d. Unique, high-solids, high-build, multifunctional coating.
e. Low VOC, Satin coating.
f. Impact Resistance, ASTM D-4226 Minimum 1.2 in/lb/mil
g. Color retention: ≤1Δ (CIE L.a.b.), Montreal 45° South: 12 months
h. Very good chemical resistance.

3. Two-component acrylic urethane enamel Gloss topcoat. (OPTIONAL)

a. Color.
b. Custom colors available consult manufacturer.
c. Unique, high-solids, high-build, multifunctional coating.

d. Low VOC, Gloss coating.
e. Impact Resistance, ASTM-D2794: 80-102 in/lb (direct), 40-80 in/lb (reverse) @ 1.5 mils thickness.
f. Color retention: Δ E < 5 (CIE L.a.b.), Florida Exposure: 18 months
g. Excellent chemical resistance.

2.07 ACCESSORIES

A. Vision Lites.

1. Factory Glazing.
2. Stainless Steel vison kit with 3/16” NGP Firelite NT, clear.
3. Size as indicated on the drawings.
4. 60 to 90-minute rated doors.

a. Maximum 704 in² in listed and labeled kit for positive pressure applications using listed glazing. Minimum 5” from top or edge of door to lite cutout and minimum 5” from latch cutout to lite cutout.
b. Maximum 32” high.
c. Maximum 22” wide.
d. Multiple lights are allowed when the sum of the areas does not exceed the tested area with the maximum length and width limitations.

5. 20 to 45-minute rate doors.

a. Listed metal vison frames and listed glazing are limited to a maximum clear view area of 616 in² per lite with a maximum of 1232 in². Lite kits exceeding 100 in² void the temperature requirements per NFPA 80 unless temperature resistive glazing is used.

B. Hardware.

1. All hardware must be listed and labeled for use in mineral core fire doors.
2. Pre-machine doors in accordance with templates from specified hardware manufactures and hardware schedule.
3. Factory install hardware.
4. EPT Units

a. Allowed between top and middle hinge locations.
b. 1/16” maximum clearance per side when installing EPT.
c. Limited to maximum 60 min positive and neutral pressure applications.
d. Intumescent caulk or strips are required on bottom, top, and side of EPT device.

5. Hardware as Scheduled.

C. Wire Raceway

1. Single swing applications only.
2. 3/8” x 3/8” bore.
3. Maximum height of 40” from bottom edge of door.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas to receive doors.

B. Notify architect of conditions that would adversely affect installation or subsequent use.

C. Do no proceed with installation until unsatisfactory conditions are corrected.

3.02 PREPARATION

A. Ensure openings to receive frames are plumb, level, square, and in tolerance.

3.03 ERECTION

A. Install doors in accordance with manufacturer's instructions.

B. Install doors plumb, level, square, true to line, and without warp or rack.

C. Anchor frames securely in place.

D. Separate aluminum from other metal surfaces with bituminous coatings or other means approved by architect.

E. Set thresholds in bed of mastic and back seal.

F. Install exterior doors to be weathertight in closed position.

G. Repair minor damages to finish in accordance with manufacturer's instructions and as approved by architect.

H. Remove and replace damaged components that cannot be successfully repaired as determined by architect.

3.04 FIELD QUALITY CONTROL

A. Manufacture's Field Services.

1. Manufacturer's representative shall provide technical assistance and guidance for installation of doors.

3.05 ADJUSTING

A. Adjust doors, hinges, and locksets for smooth operation without binding.

3.06 CLEANING

A. Clean doors promptly after installation in accordance with manufacturer's instructions.

B. Do not use harsh cleaning materials or methods that would damage finish.

3.07 PROTECTION

A. Protect installed doors to ensure that, except for normal weathering, doors will be without damage or deterioration at time of substantial completion.

END OF SECTION 081743

SECTION 082550 - ALUMINUM FRP FLUSH DOORS AND FRAMES

PART 1- GENERAL

1.1 SECTION INCLUDES

A. Fiberglass reinforced polyester (FRP) flush doors with aluminum frames.

1.2 RELATED SECTIONS

072419, Water Drainage Exterior Insulation and Finish System.
079200, Joint Sealants.
087100, Door Hardware.
088000, Glazing.
090000, Color Schedule.
092216, Non-Structural Metal Framing.
092900, Gypsum Board.

1.3 PERFORMANCE REQUIREMENTS

A. General: Provide door assemblies that have been designed and fabricated to comply with specified performance requirements, as demonstrated by testing manufacturer's corresponding standard systems.

B. Air Infiltration: For a single door 3’-0” x 7’-0”, test specimen shall be tested in accordance with ASTM E 283 at pressure differential of 6.24 psf. Door shall not exceed 0.90 cfm per linear foot of perimeter crack.

C. Water Resistance: For a single door 3’-0” x 7’-0”, test specimen shall be tested in accordance with ASTM E 331 at pressure differential of 7.50 psf. Door shall not have water leakage.

D. Indoor air quality testing per ASTM D 6670-01: GREENGUARD Environmental Institute Certified including GREENGUARD for Children and Schools Certification.

E. Hurricane Test Standards, Single Door with Single-Point Latching:

1. Uniform Static Load, ASTM E 330: Plus or minus 75 pounds per square foot.
2. Forced Entry Test, 300 Pound Load Applied, SFBC 3603.2 (b)(5): Passed.
3. Cyclic Load Test, SFBC PA 203: Plus or minus 53 pounds per square foot.
4. Large Missile Impact Test, SFBC PA 201: Passed.

F. Wind Loads: 121 mph, per requirements in Chapter 16 of the NC Building Code.

G. Blast Test, Doors and Frames, ASTM F 1642-04, 6 psi / 41 psi-msec: Minimal Hazard.

H. Swinging Door Cycle Test, Doors and Frames, ANSI A250.4: Minimum of 25,000,000 cycles.

I. Cycle Slam Test Method, NWWDA T.M. 7-90: Minimum 5,000,000 Cycles.

J. Swinging Security Door Assembly, Doors and Frames, ASTM F 476: Grade 40.

K. Salt Spray, Exterior Doors and Frames, ASTM B 117: Minimum of 500 hours.

L. Sound Transmission, Exterior Doors, STC, ASTM E 90: Minimum of 25.

M. Thermal Transmission, Exterior Doors, U-Value, AAMA 1503-98: Maximum of 0.29 BTU/hr x sf x degrees F. Minimum of 55 CRF value.

N. Surface Burning Characteristics, FRP Doors and Panels, ASTM E 84:

1. Flame Spread: Maximum of 200, Class C.
2. Smoke Developed: Maximum of 450, Class C.

O. Surface Burning Characteristics, Class A Option On Interior Faces of FRP Exterior Panels and Both Faces of FRP Interior Panels, ASTM E 84:

1. Flame Spread: Maximum of 25.
2. Smoke Developed: Maximum of 450.

P. Impact Strength, FRP Doors and Panels, Nominal Value, ASTM D 256: 15.0 foot-pounds per inch of notch.

Q. Tensile Strength, FRP Doors and Panels, Nominal Value, ASTM D 638: 14,000 psi.

R. Flexural Strength, FRP Doors and Panels, Nominal Value, ASTM D 790: 21,000 psi.

S. Water Absorption, FRP Doors and Panels, Nominal Value, ASTM D 570: 0.20 percent after 24 hours.

T. Indentation Hardness, FRP Doors and Panels, Nominal Value, ASTM D 2583: 55.

U. Gardner Impact Strength, FRP Doors and Panels, Nominal Value, ASTM D 5420: 120 in-lb.

V. Abrasion Resistance, Face Sheet, Taber Abrasion Test, 25 Cycles at 1,000 Gram Weight with CS-17 Wheel: Maximum of 0.029 average weight loss percentage.

W. Stain Resistance, ASTM D 1308: Face sheet unaffected after exposure to red cabbage, tea, and tomato acid. Stain removed easily with mild abrasive or FRP cleaner when exposed to crayon and crankcase oil.

X. Chemical Resistance, ASTM D 543. Excellent rating.

1. Acetic acid, Concentrated.
2. Ammonium Hydroxide, Concentrated.
3. Citric Acid, 10%.
4. Formaldehyde.
5. Hydrochloric Acid, 10%
6. Sodium hypochlorite, 4 to 6 percent solution.

Y. Compressive Strength, Foam Core, Nominal Value, ASTM D 1621: 79.9 psi.

Z. Compressive Modulus, Foam Core, Nominal Value, ASTM D 1621: 370 psi.

AA. Tensile Adhesion, Foam Core, Nominal Value, ASTM D 1623: 45.3 psi.

BB. Thermal and Humid Aging, Foam Core, Nominal Value, 158 Degrees F and 100 Percent

Humidity for 14 Days, ASTM D 2126: Minus 5.14 percent volume change.

1.4 SUBMITTALS **(note that this product is a long-lead time order)**

A. Product Data: Submit manufacturer's product data, including description of materials, components, fabrication, finishes, and installation.

B. Shop Drawings: Submit manufacturer's shop drawings, including elevations, sections, and details, indicating dimensions, tolerances, materials, fabrication, doors, panels, framing, hardware schedule, and finish.

C. Samples:

1. Color: Submit manufacturer's samples of standard colors of FRP sheet.

D. Maintenance Manual: Submit manufacturer's maintenance and cleaning instructions for doors, including maintenance and operating instructions for hardware.

E. Warranty: Submit manufacturer's standard warranty, to commence upon Acceptance of the Project by the Owner.

1.6 QUALITY ASSURANCE

A. Manufacturer's Qualifications:

1. Continuously engaged in manufacturing of doors of similar type to that specified, with a minimum of 25 years successful experience.
2. Door and frame components from same manufacturer.
3. Evidence of a compliant documented quality management system.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying opening door mark and manufacturer.

B. Storage: Store materials in clean, dry area indoors in accordance with manufacturer's instructions.

C. Handling: Protect materials and finish from damage during handling and installation.

1.8 WARRANTY

A. Warrant doors, frames, and factory hardware against failure in materials and workmanship, including excessive deflection, faulty operation, defects in hardware installation, and deterioration of finish or construction in excess of normal weathering.

B. Warranty Period: Ten years starting on date of shipment. In addition, a limited lifetime (while the door is in its specified application in its original installation) warranty covering: failure of corner joinery, core deterioration, delamination or bubbling of door skin.

PART 2- PRODUCTS

2.1 BASIS OF DESIGN

A. SL-17 Flush Doors with SpecLite3 fiberglass reinforced polyester (FRP) face sheets. Special-Lite, Inc., PO Box 6, Decatur, Michigan 49045. Toll Free (800) 821-6531. Phone (269) 423-7068. Fax (800) 423-7610. Web Site www.special-lite.com. E-Mail info@special-lite.com.

B. Subject to compliance with the requirements of this specifications, the following will be acceptable substitutions:

1. Eliason Corp., Easy Swing Door Div., which is located at: 9229 Shaver Rd. ; Kalamazoo, MI 49024; Toll Free Tel: 800-828-3655; Tel: 269-327-7003; Fax: 800-828-3577; Email: request info (jasonh@eliasoncorp.com); Web: www.eliasoncorp.com.
2. Kawneer Corporation, Flushline FRP Doors.

2.2 FRP FLUSH DOORS

A. Model: SL-17 Flush Doors with SpecLite3 fiberglass reinforced polyester (FRP) face sheets.

B. Door Opening Size: As indicated on the Drawings.

C. Construction:

1. Door Thickness: 1-3/4 inches.
2. Stiles and Rails: Aluminum extrusions made from prime-equivalent billet that is produced from 100% reprocessed 6063-T5 alloy recovered from industrial processes, minimum of 2-5/16-inch depth.
3. Corners: Mitered.
4. Provide joinery of 3/8-inch diameter full-width tie rods through extruded splines top and bottom integral to standard tubular shaped stiles and rails reinforced to accept hardware as specified.
5. Securing Internal Door Extrusions: 3/16-inch angle blocks and locking hex nuts for joinery. Welds, glue, or other methods are not acceptable.
6. Furnish extruded stiles and rails with integral reglets to accept face sheets. Lock face sheets into place to permit flush appearance.
7. Rail caps or other face sheet capture methods are not acceptable.
8. Extrude top and bottom rail legs for interlocking continuous weather bar.
9. Meeting Stiles: Pile brush weatherseals. Extrude meeting stile to include integral pocket to accept pile brush weatherseals.
10. Bottom of Door: Install bottom weather bar with nylon brush weatherstripping into extruded, interlocking edge of bottom rail.
11. Glue: Use of glue to bond sheet to core or extrusions is not acceptable.

D. Face Sheet:

1. Material: SpecLite3 FRP, 0.120-inch thickness, finish color throughout.
2. Protective coating: Abuse-resistant engineered surface. Provide FRP with SpecLite3 protective coating, or equal.
3. Texture: Pebble.
4. Color: To be selected from manufacturer standard range. Refer to Section 090000 “Color Schedule”.

5. Adhesion: The use of glue to bond face sheet to foam core is prohibited.

E. Core:

1. Material: Poured-in-place polyurethane foam.
2. Density: Minimum of 5 pounds per cubic foot.
3. R-Value: Minimum of 9.

F. Cutouts:

1. Manufacture doors with cutouts for required vision lites, louvers, and panels.
2. Factory-install vision lites and panels.

G. Hardware:

1. Premachine doors in accordance with templates from specified hardware manufacturers and hardware schedule.
2. Factory-install hardware, except push bar and closer.

2.3 MATERIALS

A. Aluminum Members:

1. Aluminum extrusions made from prime-equivalent billet that is produced from 100% reprocessed 6063-T5 alloy recovered from industrial processes: ASTM B 221.
2. Sheet and Plate: ASTM B 209.
3. Alloy and Temper: As required by manufacturer for strength, corrosion resistance, application of required finish, and control of color.

B. Components: Door and frame components from same manufacturer.

C. Fasteners:

1. Material: Aluminum, 18-8 stainless steel, or other noncorrosive metal.
2. Compatibility: Compatible with items to be fastened.
3. Exposed Fasteners: Screws with finish matching items to be fastened.

2.4 FABRICATION

A. Sizes and Profiles: Required sizes for door and frame units, and profile requirements shall be as indicated on the Drawings.

B. Coordination of Fabrication: Field measure before fabrication and show recorded measurements on shop drawings.

C. Assembly:

1. Complete cutting, fitting, forming, drilling, and grinding of metal before assembly.
2. Remove burrs from cut edges.

D. Welding: Welding of doors or frames is not acceptable.

E. Fit:

1. Maintain continuity of line and accurate relation of planes and angles.
2. Secure attachments and support at mechanical joints with hairline fit at contacting members.

2.6 ALUMINUM DOOR FRAMING SYSTEMS

A. Tubular Framing:

1. Size and Type: As indicated on the Drawings.
2. Materials: Aluminum extrusions made from prime-equivalent billet that is produced from 100% reprocessed 6063-T5 alloy recovered from industrial processes, 1/8-inch minimum wall thickness.
3. Applied Door Stops: 0.625-inch high, with screws and weatherstripping. Door stop shall incorporate pressure gasketing for weathering seal. Counterpunch fastener holes in door stop to preserve full metal thickness under fastener head.
4. Frame Members: Box type with 4 enclosed sides. Open-back framing is not acceptable.
5. Caulking: Caulk joints before assembling frame members.
6. Joints:
    a. Secure joints with fasteners.
    b. Provide hairline butt joint appearance.
7. Field Fabrication: Field fabrication of framing using stick material is not acceptable.
8. Applied Stops: For side, transom, and borrowed lites and panels. Applied stops shall incorporate pressure gasketing for weathering seal. Reinforce with solid bar stock fill for frame hardware attachments.
9. Hardware:
    a. Premachine and reinforce frame members for hardware in accordance with manufacturer's standards and hardware schedule.
    b. Factory-install hardware.
10. Anchors:
    a. Anchors appropriate for wall conditions to anchor framing to wall materials.
    b. Door Jamb and Header Mounting Holes: Maximum of 24-inch centers.
    c. Secure head and sill members of transom, side lites, and similar conditions.
11. Transom Lite:
    a. Factory preassemble transom lite to greatest extent possible.
    b. Mark frame assemblies according to location.

B. Frame Capping:

1. Model: SL-70.
2. Capping: With insert frame as indicated on the Drawings.
3. Finish: Match framing.

2.7 HARDWARE

A. Premachine doors in accordance with templates from specified hardware manufacturers and hardware schedule.

B. Factory install hardware, except closer and push bar.

C. Hardware Schedule: As specified in Division 08.

D. Finish: Clear.

2.8 TRANSOM AND VISION LITES

A. Factory Glazing: 1-inch glass insulating units, tempered, noted on the drawings.

B. Lites in Exterior Doors: Allow for thermal expansion.

C. Rectangular Lites:

1. Size: As indicated on the Drawings.
2. Factory glazed with screw-applied aluminum stops anodized to match perimeter door rails.

2.10 ALUMINUM FINISHES

A. Class I finish, 0.7 mills thick.

1. Clear 215 R1, AA-M10C12C22A41, Class I, 0.7 mils thick.

PART 3- EXECUTION

3.1 EXAMINATION

A. Examine areas to receive doors. Notify Architect of conditions that would adversely affect installation or subsequent use. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 PREPARATION

A. Ensure openings to receive frames are plumb, level, square, and in tolerance.

3.3 INSTALLATION

A. Install doors in accordance with manufacturer's instructions.

B. Install doors plumb, level, square, true to line, and without warp or rack.

C. Anchor frames securely in place.

D. Separate aluminum from other metal surfaces with bituminous coatings or other means approved by Architect.

E. Set thresholds in bed of mastic and backseal.

F. Install exterior doors to be weathertight in closed position.

G. Repair minor damages to finish in accordance with manufacturer's instructions and as approved by Architect and remove and replace damaged components that cannot be successfully repaired as determined by Architect.

3.5 ADJUSTING

A. Adjust doors, hinges, and locksets for smooth operation without binding.

3.6 CLEANING

A. Clean doors promptly after installation in accordance with manufacturer's instructions.

B. Do not use harsh cleaning materials or methods that would damage finish.

3.7 PROTECTION

A. Protect installed doors to ensure that, except for normal weathering, doors will be without damage or deterioration at time of substantial completion.

END OF SECTION 082550

SECTION 083160 – FLOOD PANEL SYSTEM

PART 1 - GENERAL

1.01 Description and general notes

A. Work Included:

1) Provide flood barrier(s) factory assembled with frame(s) and hardware where shown on the A-2.2 Floor Plans and the A-9.4 Door Schedule, in accordance with the contract documents.
2) All Barrier heights shall be finished to 12” min. above Base Flood Elevation (BFE) unless otherwise stated by the Architect or Engineer of Record (EOR)
3) BFE and Building Sub Elevations shall be furnished to Barrier Manufacturer by the Architect or Engineer of Record.

B. The Manufacturer shall provide a structural design for the Removable Flood Panels sealed by an Engineer registered in the State of North Carolina. These shall be designed for hydrostatic hydrodynamic and impact debris flood loads with water pressures corresponding to maximum water height and flow speed of 8 ft. /sec. up to 10 ft. /sec. in order to certify minimum required flood elevation to top of Flood Panels.

C. Determine the required Panel height and flow speed for the design of Removable Flood Panels, based on FEMA's criteria (See Note #3) as well as per ASCE 24-14 Standard. Installation and construction of these Flood Panels for use within flood hazard areas shall be in accordance with the American Society of Civil Engineers Flood Resistant Design and Construction Standard SEI/ASCE 24-14.

D. Design criteria is for Type 2 Closures in chapter 7, section 70 1.1.2 of the Army Corp of Engineers, EP 1165-2-314 12/1195 and based on the 2015 Edition of the International Building Code, the corresponding provisions of ASCE 24-14, FEMA flood proofing non-residential structures manual FEMA 102, FEMA P-936 and FEMA Technical Bulletin 3-93. Design flood loads have been determined in accordance with ASCE 7-16. Design wind loads have been determined in accordance with ASCE 7-16 for 160 mph Basic Wind Speed for Risk Category III building. This flood barrier design criteria is for buildings in an "A" or "AE" flood zone and is not to be used in a Coastal "A" zone or high velocity "V" zone.

E. The Flood Barrier design system must be tested by an independent testing lab for water infiltration in accordance with FEMA 102 manual for flood proofing of non-residential structures, specifications Section 8, Page 70. Type 2 Flood closures or barriers are permitted allowable seepage rates. Seepage amounts will vary with building conditions encountered. ASCE 24-14 chapter 6 states "sump pumps shall be provided to remove water accumulated due to any passage of vapor and seepage of water during the flooding event." Owner acknowledges and is responsible for all drains, piping and sump pumps required to meet ASCE 24-14 requirements to offset water build up behind the barrier system. These materials and equipment are not provided by Flood Panel.

F. Flood Panel manufacturer shall install and use gaskets and approved sealants following all the recommendations and specifications of the manufacturers respectively.

G. Owner, General contractor or installer to verify all dimensions, wall and floor conditions at site before proceeding with the work, and shall notify this engineer if any discrepancy is found that would alter the structural design of these Flood Panels.

H. Existing slabs and walls adjacent to opening where Flood Panel is to be installed shall be given a surface treatment by means of water proof sealer before flood Panel is installed. Surface must be smooth, square, plumb and level.

I. Existing slabs and walls adjacent to openings where Flood Panels are to be installed shall be structurally designed by engineer of record, to sustain the same hydrostatic, hydrodynamic and impact pressures that correspond to maximum water elevation above finished floor at top of Panel, based on criteria mentioned on Note #3.

J. Drop-in anchors embedded into concrete for removable support installation shall be covered with a cap or similar device to protect their inside hold from dust, so that machine screws can easily be installed at time of flood warning. Concrete anchors by others.

K. Separation of Panel to window/door shall be measured from back of Panel to window/door including any knob, handle, or protruding device, and shall be 2" minimum.

L. All aluminum extrusions to be 6161-T6 alloy, 6063-T6 alloy, and 6005-T6 alloy.

M. All sheet metal screws shall be as manufactured by ITW/Buildex "TEK Screws", and to be made of non-corrosive material.

N. All bolts to be galvanized steel ASTM A-307 designation or 304 Series Stainless Steel.

O. All gaskets installed shall be neoprene.

P. All welding to conform to the American Welding Society AWS D1.2/d1.4m 2017 Regulations. Use certified welders. Use ER-5356 Electrodes for aluminum a E70 for steel.

Q. Surfaces against which the sealing gasket presses must be built "paper-smooth" to prevent excessive water extrusion, beyond that allowed by requirements. All surfaces must be plumb, square and level.

1.02 Standards

A. Comply with the provisions of (as applicable).

1) AWS Structural Welding Code D1.2/D1.4M 2017 Reg.
2) ASTM A36, A240,
3) ASCE 7-16, ASCE 24-14, SEI/ASCE 24-14
4) FBC Chapter 20, Section 2003.8.4.
5) QA program that is registered to ISO 9001·2000
6) 2018 North Carolina Building Code (based upon the 2015 Edition of the International Building Code)
7) FEMA 3-93, FEMA 102, FEMA P-936

1.03 Submittals

A. Calculations and signed and sealed drawings:

1) Submit calculations, approved by the manufacturer’s North Carolina engineer, to verify the barrier's ability to withstand the design pressure loading, based on current building code and specified load combinations, including signed and sealed drawings and calculations.

B. Shop Drawings:

1) Submit shop drawings for flood barriers including dimensioned plans and elevations, sections, connections and anchorage.

C. Manufacturers Data:

1) Submit installation and maintenance instructions for flood barriers.

D. Warranties

1) Provide manufacturer's warranty and warranty qualification stating that flood barriers for above project will be free from defects and workmanship for a period of one (1) year from date of substantial completion.
2) Flood Certificate, signed final inspection by EOR of installed flood barriers and final installation pictures of each opening is required by Flood Panel to issue a warranty.

E. Flood Certificate

1) Responsibility for filing the building FEMA "Flood Proofing Certificate" is the responsibility of the Owner.
2) Flood Emergency Operation Plan per FEMA 3-93 is the responsibility of Building Owner.

F. Inspection and Maintenance Plan per FEMA 3-93

1) Responsibility of Building Owner

1.04 Qualifications

A. Experience:

1) The manufacturer of the flood barrier(s) shall present evidence attesting to at least 5 years of successful experience in the design, manufacture, and site implementation of the flood barrier system type specified.

PART 2 - PRODUCTS

2.01 Flood Panel System Manufacturers

A. Flood Barriers (Basis-of-Design):
Flood Panel
1555 Jupiter Park Drive STE 5
Jupiter, Florida 33418
860-222-3055
Email: info@floodpanel.com Web: www.floodpanel.com

B. Flood Barrier Distributors:
19 Mantua Road
Mount Royal, NJ 08061
800-507-0865
Email: info@floodproofing.com Web: www.floodproofing.com

Flood Log labels noted after Manufacturers' List are proprietary names of the above company.

C. Subject to meeting the requirements of this specification, Products by the following manufacturers will be acceptable:

Flood Barrier Inc.
7314 N.W. 46th Street.
Miami, Florida 33166
(305) 594-7929
https://floodbarrier.com/

Garrison Systems LLC
New York, NY
929-299-2099
https://garrisonflood.com

2.02 Materials

A. Aluminum Flood Log (PP) Panels to be of 6005-T6

B. Intermediate and End Posts:

1) Wall supports extrusions to be 6061-T6 alloy or primed carbon steel from grade ST37 (S235 JR) or galvanized steel with the exception of below ground supports which are to be of grade 304 stainless steel or equal.
2) Mid-span and Corner supports are to be 6061-T6 aluminum alloy (Mid-span only) or painted carbon steel from grade ST37 (S235 JR) or galvanized steel.

C. All steel to be primed with one coat Sherwin Williams Kern Flash rust inhibitive, lead free, primer, or equivalent.

D. Base Gaskets to be sandwich composite combination low/high compressed set gaskets mechanically retained in the flood logs; 40D medium compression set gaskets retained mechanically in the top of each flood log and low compression gaskets in the jambs and mid-span supports.

2.03 Design

A. Loads for the design of the Flood Log Flood Panel System (PP) have been determined assuming that the location of the building where the system is to be installed is outside of High Risk Flood Hazard Areas, Coastal High Hazard Areas, and Coastal A zones, per Dry Flood proofing Limitations on ASCE 24-14, Section 6.2.1.

B. This Flood Log System Flood Panel System (PP) has been designed for the loads and load combinations listed on the ASCE 7-16, Section 2.0 (Combinations of Loads), including the following flood loads according with ASCE 7-16 Section 5.4 (Loads During Flooding):

Hydrostatic Loads, caused by water which is either stagnant or moves at velocities less than 8 ft./sec., according with ASCE 24-14, Section 6.2.1 and ASCE 7-16, Sections 5.4.2 and C5.4.2.

2) Hydrodynamic and Impact Loads: Not considered since the use of Dry Floodproofing is limited to flood velocities less than 5 ft/sec.

C. This Flood Log System Flood Panel System (PP) is designed for a maximum wind load pressure of +/- 100 psf, which is the maximum wall wind load pressure per Structural Drawings.

D. Frame(s) and Intermediate post(s) shall have mounting holes for connecting anchors and bolts. Anchor type, size, and method dependent on load capabilities of structure.

E. The individual Flood log sections shall be 3” deep by 12.25” tall with a top interlocking gasket slot system which includes gaskets and gasket channels between sections and full height in the jamb channels. Multiple logs are to be stacked to meet or exceed the base flood elevation plus additional 12” or 24” for wave action per the job requirements and location. Embed plates may be required at the sill and jambs based on the condition at the opening and the loads imposed on the system. Jamb supports are to be continuous structural steel channels designed specifically for the Flood log system and are to be anchored and sealed to the condition with embeds or mechanical anchors.

PART 3 - EXECUTION

3.01 Installation

A. Install flood barriers in accordance with manufacturer's instructions and approved shop drawings.

B. Building contractor to verify that all surfaces against which the sealing gasket presses must be built "paper-smooth" to prevent excessive water extrusion, beyond that allowed by requirements. All surfaces must be plumb, square and level before installation can begin.

C. All embed plates are to be installed using Dow Corning 995 caulk or equal or waterproof grout at back of support covering full height and width of support and producing squeeze out on all sides to assure proper seal. Sealer by others.

D. Existing slabs, walls and columns adjacent to openings where flood barriers are to be installed shall be waterproofed with a waterproof membrane or a water proof sealer surface treatment prior to the installation of the flood barriers by the contractor.

E. All fixed mill finish aluminum supports must have a protective barrier between the support and the concrete and any dissimilar metals to prevent corrosion.

F. Install all supports true and plumb without racking or warping.

G. For Flood Panel to warranty the product supplied, the Flood Barrier installer must provide photos of each opening during and following installation. Inspection of each opening is required per the Flood Certificate by the Engineer of record to verify installation compliance with the manufacturers shop drawings and installation instructions. Installer can then uninstall the barrier system and the building contractor shall move the barriers to a storage location as directed by the Architect or Owners representative.

3.02 Cleaning, Inspection and Storage

A. Inspect all barriers for damaged parts

B. Repair or replace damaged installed products and components

C. Touch up all damaged surfaces

D. Clean all exposed surfaces and let dry before storing

3.03 Protection

A. Building contractor to move all barriers to designated storage location and shall stack the barriers in a manner that does not damage the gaskets. Position all gaskets away from high traffic areas in the storage area to prevent damage to the gaskets.

B. Protect installed product and finish surfaces from damage during handling, storage and installation.

C. Protect all installed product and finished surfaces during normal and general operation.

END OF SECTION 083160

SECTION 083323 - INSULATED ROLLING SERVICE DOOR

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes: Manual overhead insulated rolling doors.

B. Related Sections:

1. 055000 - Metal Fabrications. Door opening jamb and head members.
2. 061053 - Rough Carpentry. Door opening jamb and head members.
3. 083100 - Access Doors and Panels. Access doors.
4. 087100 - Hardware. Padlocks. Master keyed cylinder.
5. 099123 - Painting. Field painting.

C. Products That May Be Supplied, But Are Not Installed Under This Section:

1. Control Station

1.2 SYSTEM DESCRIPTION

A. Design Requirements:

1. Air Infiltration to Comply With:

a. ASHRAE® (American Society of Heating, Refrigeration, and Air-Conditioning Engineers) Standard 90.1-2007, 2010 & 2013 requirements of less than .3 CFM/FT2
b. IECC® (International Energy Conservation Code) 2021 requirements of less than 0.9 CFM/FT2
c. California Title 24 requirements of less than 0.9 CFM/FT2

2. Wind Loading:

a. Supply doors to withstand up to 160 MPH design wind load.

3. Cycle Life:

a. Design doors of standard construction for normal use of up to 20 cycles per day maximum, and an overall maximum of 50,000 operating cycles for the life of the door.

4. Seismic Performance:

a. Provide manufacturer’s seismic calculations confirming ASCE7-10

5. Insulated Door Slat Material Requirements:

a. Flame Spread Index of 35 and a Smoke Developed Index of 400 as tested per ASTM E84

b. Sound Transmission Class (STC) rating up to 27 for the entire assembly. All configurations are evaluated per ASTM E90 and based on testing a complete, operable assembly
d. U-factor listing of 0.532 for entire door assembly per DASMA-105
e. Insulation to be CFC Free with an Ozone Depletion Potential (ODP) rating of zero.

6. Safety:

a. Chain operated doors shall be designed so that the door immediately stops upward or downward travel and is maintained in a stationary position when the hand chain is released by user.

7. Delegated Design:

a. Design rolling service door systems, including comprehensive engineering analysis by a qualified North Carolina-registered professional engineer, using performance requirements and design criteria indicated.

8. Wind Loads:

a. Refer to North Carolina State Building Code requirements as noted on Drawing R0.1, in Section “Structural Design”. Assume 153 mph wind speed per requirements in Chapter 16 of the NC Building Code.

1.3 SUBMITTALS

A. Reference Section 013300 Submittal Procedures; submit the following items:

1. Product Data

2. Shop Drawings: Include special conditions not detailed in Product Data. Show interface with adjacent work.

3. Quality Assurance/Control Submittals:

a. Provide manufacturer ISO 9001:2015 registration
b. Provide manufacturer's installation instruction

4. Closeout Submittals:

a. Operation and Maintenance Manual
b. Certificate stating that installed materials comply with this specification

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer Qualifications: ISO 9001:2015 registered and a minimum of five years experience in producing doors of the type specified

2. Installer Qualifications: Manufacturer's approval

1.5 DELIVERY STORAGE AND HANDLING

A. Follow manufacturer's instructions

1.6 WARRANTY

A. Standard Warranty: Two years from date of shipment against defects in material and workmanship

B. Maintenance: Submit for owner's consideration and acceptance of a maintenance service agreement for installed products

PART 2 – PRODUCT

2.1 MANUFACTURER

A. Manufacturer:

1. Cookson: 1901 South Litchfield Road, Goodyear, AZ 85338.
   Telephone: (855) 719-4040
2. Model: ESD40.

2.2 PRODUCT INFORMATON

A. Equivalent products matching the requirements of the Specification that are manufactured by the following companies will be acceptable.

1. Overhead Door Company
2. Alpine Overhead Doors

2.3 MATERIALS

A. Curtain: Thermally broken; Air infiltration rate of 0.29 CFM/FT2, as tested per ASTM E283 validated by an independent testing agency.

1. Fabrication:

a. Slat Material: No. 6B

1) 316 stainless steel.

b. Insulation: 7/8 inch (22 mm) thick fire-retardant mineral wool, ASTM C665-95 or ASTM C612-93
c. Total Slat Thickness: 15/16 inch (24 mm)
d. Flame Spread Index of 35 and a Smoke Developed Index of 400 as tested per ASTM E84

2. Finish (Slats only):

a. #4 finish.

B. Endlocks: Fabricate interlocking sections with high strength galvanized cast iron endlocks on alternate slats each secured with two ¼" (6.35 mm) rivets. Provide windlocks as required to meet specified wind load.

1. Galvanized cast iron: Required if above 21'-0" width (DBG - Distance Between Guides), applicable for smaller configurations requiring wind load.

C. Bottom Bar

1. Configuration:

a. Structural Steel Angles (Standard on doors larger than 21.5' DBG): 2 structural steel angles minimum 2"x2"x1/8"

2. Finish:

a. Hot-dip Galvanized: ASTM A 123, Grade 85 zinc coating, hot-dip galvanized after fabrication

3. Air Infiltration Certification Label: Must be affixed to bottom bar

D. Guides:

1. Fabrication:

a. Minimum 3/16 inch (4.76 mm) structural steel angles. Provide windlock bars of same material when windlocks are required to meet specified wind load. Top of inner and outer guide angles to be flared outwards to form bellmouth for smooth entry of curtain into guides. Provide removable guide stoppers to prevent over travel of curtain and bottom bar.

b. Top 16 ½" (419.10 mm) of coil side guide angles to be removable for ease of curtain installation and as needed for future curtain service

2. Finish:

a. Hot-dip Galvanized: ASTM A 123, Grade 85 zinc coating, hot-dip galvanized after fabrication

E. Counterbalance Shaft Assembly:

1. Barrel: Steel pipe capable of supporting curtain load with maximum deflection of 0.03 inches per foot (2.5 mm per meter) of width
2. Spring Balance: Oil-tempered, heat-treated steel helical torsion spring assembly designed for proper balance of door to ensure that maximum effort to operate will not exceed 25 lbs. (110 N). Provide wheel for applying and adjusting spring torque.

F. Brackets:

Fabricate from minimum 3/16-inch (5 mm) steel plate with permanently lubricated ball or roller bearings at rotating support points to support counterbalance shaft assembly and form end closures

1. Finish:

a. Hot-dip Galvanized: ASTM A 123, Grade 85 zinc coating, hot-dip galvanized after fabrication

G. Hood:

Minimum 24-gauge galvanized steel with reinforced top and bottom edges. Provide minimum ¼-inch (6.35 mm) steel intermediate support brackets as required to prevent excessive sag.

1. Finish:

a. GalvaNex™ Coating System (Stock Colors):

1) ASTM A 653 galvanized base coating treated with dual process rinsing agents in preparation for chemical bonding baked-on base coat and gray baked-on polyester finish coat

H. Weatherstripping:

1. Bottom Bar:

a. Manually Operated Doors: Replaceable, bulb-style, compressible EDPM gasket extending into guides

2. Guides: Replaceable vinyl strip on guides sealing against both sides of curtain
3. Lintel Seal: Double brush seal with EPDM sandwiched between the two brush seals at door header to impede air flow.
4. Hood: Neoprene/rayon baffle to impede air flow above coil
5. Guide Seal: For face of wall applications, a foam block will be supplied for the area between the inner guide angle and wall construction. For between jambs applications, silicone around each angle joint will be required.

2.4 OPERATION

A. Manual ControlGard Chain Hoist: Provide chain hoist operator with endless steel chain, chain pocket wheel and guard, geared reduction unit, and chain keeper secured to guide. Chain hoist to include integral brake mechanism that will immediately stop upward or downward travel and maintain the door in a stationary position when the hand chain is released by the user

2.5 ACCESSORIES

A. Locking:

1. Master keyable cylinder operable from both sides of bottom bar, options for all types of operation. Provide interlock switches on Motor operated units.

a. Schlage, to match Owner’s keying system for the building.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates upon which work will be installed and verify conditions are in accordance with approved shop drawings.

B. Coordinate with responsible entity to perform corrective work on unsatisfactory substrates.

C. Commencement of work by installer is acceptance of substrate.

3.2 INSTALLATION

A. General: Install door and operating equipment with necessary hardware, anchors, inserts, hangers and supports.

B. Follow manufacturer's installation instructions.

3.3 ADJUSTING

A. Following completion of installation, including related work by others, lubricate, test, and adjust doors for ease of operation, free from warp, twist, or distortion

3.4 CLEANING

A. Clean surfaces soiled by work as recommended by manufacturer.

B. Remove surplus materials and debris from the site.

3.5 DEMONSTRATION

A. Demonstrate proper operation to Owner's Representative.

B. Instruct Owner's Representative in maintenance procedures.

END OF SECTION 083323

SECTION 083919 - WATERTIGHT DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Single Swing and Paired Swing with removable mullion Pedestrian Flood Doors with Frames.
2. Door Hardware.

B. Related Sections:

1. Division 03 – Cast-In-Place Concrete.
2. Division 04 – Concrete Unit Masonry
3. Division 05 – Structural Steel Framing.

1.2 SUBMITTALS

A. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation instructions.

B. Shop Drawings: Provide shop drawings showing layout, profiles, and product components, including anchorage, hardware, and finishes. Include dimensional plans, applicable material specifications, elevations and sections detailing mounting and connections, and load diagrams.

1. Contractor to provide manufacturer with field measurements and mounting structure prior to commencement of shop drawings.

C. Factory Testing Documentation: Furnish independent party witnessed factory testing documentation of the same model/type pedestrian flood door demonstrating a maximum leakage rate of 0.040 gallon per hour per linear foot of wetted perimeter, tested in accordance with the procedure set forth by the American National Standard for Flood Mitigation Equipment in ANSI/FM Approvals 2510-2020 section 4.3.3 for a minimum of 22 hours. Maximum leakage rate shall be published as the greater of the leakage rates recorded at both 10% and 100% of the maximum test water height. Leakage shall be collected through all portions of the product assembly which are below the test water depth, including hardware and lockset.

D. Calculations: Upon signed finalization and approval of dimensions, mounting location material and configuration, and load requirements;

1. Submit stamped calculations by a registered professional engineer from within the state or territory where the project will be constructed or substantially improved, to verify the flood door’s ability to withstand the design loading.

1 1.3 CLOSEOUT SUBMITTALS

2 A. Provide Operation and Maintenance data to include methods for maintaining installed products,
3 precautions against cleaning materials and methods detrimental to finishes and performance.

4 1.4 QUALITY ASSURANCE

5 A. Manufacturer Qualifications: Manufacturer must demonstrate a minimum of five (5) years
6 successful experience in design and manufacture of similar flood related closures. Upon request,
7 provide supporting evidence including list of installations, descriptions, name, and method of
8 contact.

9 B. Minimum Qualifications: Manufacturer must demonstrate compliance and certification of a Quality
10 Management System administered by the International Organization for Standardization (ISO).
11 Documentation of current certification status to be provided upon request.

12 C. Welder Qualifications: Welders Certified in accordance with American Welding Society
13 Procedures for applicable material used in production of specified product.

14 1.5 DELIVERY, STORAGE, AND HANDLING

15 A. Store products in manufacturer's unopened packaging container with identification markings
16 intact until ready for installation.

17 B. Protect materials from exposure to moisture during storage.

18 C. Store materials in a dry, warm, ventilated weathertight location. If outdoor storage is required,
19 block materials to store at an incline, to prevent pooling of any moisture and promote runoff. Tarp
20 materials in a tent-like arrangement, elevated above the product with open sides to allow airflow.
21 Store loose or high value components in a dry, controlled environment.

22 D. Use caution when unloading and handling product to avoid bending, denting, crushing, or other
23 damage to the product.

24 E. When using forklifts, use forks of proper length to fully support product being moved. Consult
25 "Approved for Construction" drawings or consult with factory for proper lift points.

26 1.6 PROJECT CONDITIONS

27 A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits
28 recommended by manufacturer for optimum results. Do not install products under environmental
29 conditions outside manufacturer's indicated limits.

30 1.7 COORDINATION

31 A. Conduct site survey and provide to flood door manufacturer, prior to manufacturer’s
32 commencement of shop drawings, the actual site conditions of the mounting location, to include;
33 material type, dimensions and configuration, interferences with mounting surface, or any other
34 condition that may impact the ability of the flood door to be properly installed.

35 B. Coordinate work with other operations and installation of adjacent materials to avoid damage.

36 1.8 WARRANTY

A. Manufacturer's Standard Warranty: Product to be free from defects in material and workmanship for a period of one (1) year from date of Acceptance by Owner.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Design flood resistance doors to support, solely or in combinations of, temporary super-imposed live loads as indicated below. All applied types of flood related loadings are transferred from the flood product barriers, solely or in combinations of, by mullion anchorage to structural floor slabs and/or jamb anchorage and direct pressure contact to structural walls or other structural elements.

1. Hydrostatic Loading
2. Wind Loading (Exterior applications only)

B. Engineer Code Practices: Engineer flood products to conform to the design requirements that are based on the latest adopted edition of the International Building Code (IBC). LFRD and/or ASD methodologies are applied as appropriate to align with specific project specifications and/or limited published material data.

C. Factory Testing Documentation: Furnish independent party witnessed factory testing documentation of the same model/type pedestrian flood door demonstrating a maximum leakage rate of 0.040 gallon per hour per linear foot of wetted perimeter, tested in accordance with the procedure set forth by the American National Standard for Flood Mitigation Equipment in ANSI/FM Approvals 2510-2020 section 4.3.3 for a minimum of 22 hours. Maximum leakage rate shall be published as the greater of the leakage rates recorded at both 10% and 100% of the maximum test water height. Leakage shall be collected through all portions of the product assembly which are below the test water depth, including hardware and lockset.

D. Water Density: 64 pcf, unless otherwise noted on drawings.

2.2 PEDESTRIAN FLOOD DOOR WITH FRAME

A. Description: Hinged, Pedestrian Flood Door including door frame, door panel, threshold, and door hardware.

1. Approved Manufacturer: PS Flood Barriers™, which is located at: 1150 S. 48th Street, Grand Forks, ND 58201; Toll Free Tel: 877.446.1519; Email: 4psinfo@psindustries.com; Web: www.psfloodbarriers.com or www.psindustries.com

    a. Basis of Design Product: Model: Hydro1-PD520.

B. Equivalent products meeting the requirements of this specification include units by Flood Panel, Jupiter, FL and Floodproofing.com, Mt Royal, NJ.

C. Single Source Responsibilities: Obtain all watertight doors and flood protection barriers from single manufacturer.

2.3 EQUIPMENT

A. Products Details:

1. Sealing Requirements: Flood Door and compression gasket design shall provide an effective barrier against short-term high-water situations, to the protection level indicated on drawings.
2. Operation:

    a. Door hardware operable from both sides. Flood Door shall utilize only the manufacturer's standard door hardware to create water-tight seal. No secondary latching or additional operations are acceptable.
    b. Flood Door utilized in emergency egress openings shall unlatch via activation of emergency egress panic hardware device. No secondary latching or additional operations are acceptable.

3. Mounting/Load Transfer: Anchor to existing structure. Flood Door designed for specified hydrostatic pressure (and other loads as specified) and will transfer loads to adjacent structure.
4. Frames to be anchored utilizing mechanical, chemical or other framing methods as designed. Manufacturer to include all anchors, water-stop, and sealants, as designed.
5. Loading Direction:

    a. Positive Pressure Loading, (direction of loading against flood door so as to further compress gaskets against flood door frame - "seating").

6. Provide rectangular door opening with square corners to facilitate easy passage.
7. Provide continuous, compression gasket which does not require air inflation.

2.4 MATERIALS

A. Exposed sheet metal of door panel and door frame to be formed of the following material type;

1. Stainless Steel: Type 316- No. 4 stainless steel of appropriate size and strength, welded and structurally bonded.

B. Flood door internal structure and mullion tube to be structural tubes, plates, and formed shapes of the following material type;

1. Stainless Steel Type 316: stainless steel of appropriate size and strength with welded construction.

C. Gaskets: Factory mounted, continuous, compressible rubber type, field replaceable. Gasket does not require air inflation.

1. Material: UV resistant EPDM, neoprene and rubber unless otherwise noted.
2. Location: Recessed into door perimeter, no gasket along threshold/walking surface.

D. Door Frame to be manufactured of the same material type and finish as door panel. Frame to include jambs, header jamb, and threshold members for field locating and installation on structure. Jamb members to be designed and fabricated with appropriate material as required for the loading.

E. Thresholds to be PS Flood Barriers™ proprietary threshold:

1. Aluminum: 6000 Series Alloy.

    a. ADA Compliant threshold (no more than ½" high).

b. Gasket-Free walking surface.

F. Frame Mounting Hard ware: Provide anchors, sealant, and water stop, as required.

G. Operating Hardware: Provide hardware appropriate for the size and weight of the flood door and loads. Hardware to be factory located on jambs and door panels, as practical. Latching hardware to be as indicated on drawings. Flood door panel to be factory prepared for applicable latching devices.

1. ~~Aluminum (AL689 finish) Hinge to be continuous type.~~ See Door Hardware, Section 087100.
2. ~~Standard Latching/Locking Hardware: Interior: Von Duprin 98/99 series Rim exit device. Exterior: Von Duprin 996L Lever, classroom function. (Note: this hardware has been specifically chosen and tested on the Hydro 1 PD-520, substitutions require manufacturer's engineering review.)~~

~~a. Closer; Townsteel TDC40 H-CUSH, Heavy Duty Grade 1 (AL689 finish)~~

H. Finish:

1. Stainless Steel products to be mill finish, welds are ground smooth, not polished.

a. No. 4 brushed, welds chemically passivated and cleaned.

I. Labeling: Each watertight door and frame will be individually identified for matched installation.

2.5 FABRICATION

A. Fit and factory assemble items in largest practical sections, for shipment to site.

B. Fabricate items with joints tightly fitted and secured.

C. Supply components required for anchorage of fabrications, unless otherwise noted.

D. Conduct shop operational test with factory installed gaskets to verify flood door assembly components operate as designed and flood protective gasket alignment and contact surfaces interact as intended.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not begin installation until mounting substrates have been properly prepared.

B. If substrate preparation is the responsibility of another subcontractor, notify Architect of uncompleted preparation before proceeding.

C. Inspect opening for compliance with door manufacturer requirements. Verify open conditions are within required tolerances.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's installation instructions, "Approved for Construction" drawings, shipping, handling, and storage instructions, and product carton instructions for installation.

B. Frames must be installed level, square, plumb, and rigid.

C. Perform chalk test for gasket alignment, continuity contact and pre-compression prior to field grouting.

D. Sealants, water-stop, and grouting to be applied per product application directions and in accordance with manufacturer's instructions, and "Approved for Construction" drawings.

E. Field Grouting to be completed by appropriate personnel, and in accordance with product application directions, manufacturer's instructions, and "Approved for Construction" drawings.

F. Tolerances: All dimensional requirements must be in accordance with manufacturer's installation instructions and "Approved for Construction" drawings.

G. Products to be operated and field verified that sealing surfaces maintain contact at the correct sealing points.

H. Inspect gaskets for damage, wear, and adhesion. Replace compromised gaskets immediately.

I. Verify all anchorage is in accordance with manufacture's installation instructions and applicable data sheets.

J. Inspect installation sealants to ensure a watertight juncture.

3.4 FIELD QUALITY CONTROL

A. Field Testing:
   1. Installer to perform hose test of door to frame in accordance with manufacturer’s standard Hose Test Procedure.
   2. Installer to construct temporary water barrier and test installed flood barrier under hydrostatic conditions.

3.5 CLEANING

A. Touch-up, repair or replace damaged products or components before Substantial Completion.

B. Clean all sealing surfaces.

3.6 PROTECTION

A. Protect installed products until completion of project.

END OF SECTION 083919

SECTION 084113 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior storefront framing.
2. Storefront framing for punched openings.
3. Exterior manual-swing entrance doors and door frame units.
4. Interior manual-swing entrance doors and door frame units.
5. Insulated metal panel inserts.

B. Related Sections:

1. Section 033000, Cast-in-Place Concrete.
2. Section 042100, Unit Masonry.
3. Section 054000, Cold-Formed Metal Framing.
4. Section 061053, Miscellaneous Rough Carpentry.
5. Section 074219, EIFS.
6. Section 076200, Sheet Metal Flashing and Trim.
7. Section 079200, Joint Sealants.
8. Section 081416, Flush Wood Doors.
9. Section 082550, Aluminum FRP Flush Doors and Frames.
10. Section 087100, Door Hardware.
11. Section 088000, Glazing.
12. Section 088500, Special Glazing.
13. Section 089000, Louvers and Vents.

1.2 PERFORMANCE REQUIREMENTS

A. General Performance: Aluminum-framed systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction:

1. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
2. Dimensional tolerances of building frame and other adjacent construction.
3. Failure includes the following:
    a. Deflection exceeding specified limits.
    b. Thermal stresses transferring to building structure.
    c. Framing members transferring stresses, including those caused by thermal and structural movements to glazing.
    d. Noise or vibration created by wind and by thermal and structural movements.
    e. Loosening or weakening of fasteners, attachments, and other components.
    f. Failure of operating units.

B. Delegated Design: Design aluminum-framed systems, including comprehensive engineering analysis by a qualified North Carolina-registered professional engineer, using performance requirements and design criteria indicated.

C. Wind Loads: Refer to North Carolina State Building Code requirements as noted on Drawing R0.1, in Section “Structural Design”. Assume 153 mph wind speed per requirements in Chapter 16 of the NC Building Code.

1.3 ACTION SUBMITTALS **(note that doors are a long lead time order)**

A. Product Data: For each type of product indicated.

B. Shop Drawings: For aluminum-framed systems. Include plans, elevations, sections, details, and attachments to other work.

1. Include details of provisions for system expansion and contraction and for drainage of moisture in the system to the exterior.

C. Samples: For each type of exposed finish required.

D. Delegated-Design Submittal: For aluminum-framed systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Warranties: Sample of special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Engineering Responsibility: Prepare data for aluminum-framed systems, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in systems similar to those indicated for this Project.

C. Accessible Entrances: Comply with applicable provisions in ICC/ANSI A117.1.

D. Source Limitations for Aluminum-Framed Systems: Obtain from single source from single manufacturer.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Acceptance by Owner.

B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes do not comply with requirements or that fail in materials or workmanship within specified warranty period. Warranty does not include normal weathering.

1. Warranty Period: Five years from date of Acceptance by Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide EFCO Corporation Model S403, for exterior storefront, Model S401, for interior storefront, and D500 Entrances, or comparable products by one of the following:

1. Kawneer Trifab VG 451 T, (exterior), Trifab 400 (interior), Wide Stile 500 doors.
2. Oldcastle Building Envelope.
3. TRACO.
4. Tubelite.
5. YKK AP America Inc.

2.2 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

1. Sheet and Plate: ASTM B 209 (ASTM B 209M).
2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
3. Extruded Structural Pipe and Tubes: ASTM B 429.
4. Structural Profiles: ASTM B 308/B 308M.
5. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

B. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer, complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.

1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
2. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
3. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.3 FRAMING SYSTEMS

A. Framing Members: Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required for supporting imposed loads.

1. Construction: Thermally broken
2. Glazing System: Retained mechanically with gaskets on four sides.
3. Glazing Plane: Center.

B. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with non-staining, nonferrous shims for aligning system components.

C. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories compatible with adjacent materials.

1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
2. Reinforce members as required to receive fastener threads.

D. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts, complying with ASTM A 123/A 123M or ASTM A 153/A 153M.

E. Concealed Flashing: Manufacturer's standard corrosion-resistant, non-staining, non-bleeding flashing compatible with adjacent materials.

F. Framing System Gaskets and Sealants: Manufacturer's standard, recommended by manufacturer for joint type.

2.4 GLAZING SYSTEMS

A. Glazing: As specified in Section 088000 "Glazing."

B. Glazing Gaskets: Manufacturer's standard compression types; replaceable, molded or extruded, of profile and hardness required to maintain watertight seal. **Color shall be Grey.**

C. Spacers and Setting Blocks: Manufacturer's standard elastomeric type.

2.5 ENTRANCE DOOR SYSTEMS

A. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing operation.

1. Door Construction: 1 ¾ -inch overall thickness, with minimum 0.188-inch- (4.8-mm-) thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
2. Door Design: Wide stile; 5-inch (127-mm) nominal width.
    a. Accessible Doors: Smooth surfaced for width of door in area within 10 inches (255 mm) above floor or ground plane.
3. Glazing Stops and Gaskets: Beveled, snap-on, extruded-aluminum stops and preformed gaskets.
    a. Provide non-removable glazing stops on outside of door.

B. Entrance Door Hardware: As specified in Section 087100 "Door Hardware" except as described below.

2.6 ENTRANCE DOOR HARDWARE

A. General: Provide entrance door hardware for each entrance door to comply with requirements in this Section and Section Door Hardware 087100. Items following are provided by the Door Manufacturer. Items in Section Door Hardware 087100 are provided by the Contractor’s Hardware supplier.

B. Continuous-Gear Hinges: By Hardware Supplier.

C. Strikes: Provide strike with black-plastic dust box for each latch or lock bolt; fabricated for aluminum framing.

D. Removable Mullions: BHMA A156.3, extruded aluminum. By Hardware Supplier.

E. Weather Stripping: Manufacturer's standard replaceable components.

F. Weather Sweeps: By Hardware Supplier.

2.7 ACCESSORY MATERIALS

A. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos; formulated for 30-mil (0.762-mm) thickness per coat.

B. Provide Stool Trim and Stool Trim Clips on interior, as detailed on the drawings, of same material as storefront; Part 1481, 8 inches wide, and Part 9873, continuous clip. Provide .050 clear anodized aluminum break metal sill on exterior of storefront and windows.

C. Provide extruded aluminum tubes at intersecting corners of storefront and where walls abut storefront, as shown on the drawings.

D. Insulated Metal Panels in Glazing Gaskets:

1. Provide Insulated Metal Panels as manufactured by High Standard Inc., Jaffrey, New Hampshire; www.hsipanels.com, or equivalent product matching the specifications.
2. Panel construction: Face metal/corrugated plastic/polyisocyanurate/corrugated plastic/back metal, one-inch thickness. Face metal shall be .032 Class II clear anodized aluminum.

2.8 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
4. Physical and thermal isolation of glazing from framing members.
5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
6. Provisions for field replacement of glazing from interior.
7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

E. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.

F. Entrance Doors: Reinforce doors as required for installing entrance door hardware.

G. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.

H. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.9 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure non-movement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
6. Seal joints watertight unless otherwise indicated.

B. Metal Protection:

1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or applying sealant or tape, or by installing nonconductive spacers as recommended by manufacturer for this purpose.
2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.

D. Set continuous sill members and flashing in full sealant bed as specified in Section 079200 "Joint Sealants" to produce weathertight installation.

E. Install components plumb and true in alignment with established lines and grades, and without warp or rack.

F. Install glazing as specified in Section 088000 "Glazing."

G. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.

1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping. At double doors, coordinate with the hardware supplier for a tight seal at removable mullions and astragals. Weatherstripping shall be continuous on top and sides; door bottom weather sweeps shall run the full length of the door bottom.
2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

3.2 FIELD QUALITY CONTROL

A. Repair or remove work if inspections indicate that it does not comply with specified requirements.

END OF SECTION 084113

SECTION 084123 - ALUMINUM-FRAMED SLIDING MALL FRONT DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Commercial Automatic Sliding Door. Reference ANSI/BHMA A156.10 for safety requirements.
2. Panel Exterior Bi-Part Automatic Door System with DC Motor.
3. Microprocessor Control, Safety Sensors, and Hardware.

B. Related Sections:

1. Section 033000, Cast-in-Place Concrete.
2. Section 042100, Unit Masonry.
3. Section 054000, Cold-Formed Metal Framing.
4. Section 061053, Miscellaneous Rough Carpentry.
5. ***Section 088000, Glazing is not included by door manufacturer.***

1.2 PERFORMANCE REQUIREMENTS

A. General Performance: Aluminum-framed systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction:

1. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
2. Dimensional tolerances of building frame and other adjacent construction.
3. Failure includes the following:
    a. Deflection exceeding specified limits.
    b. Thermal stresses transferring to building structure.
    c. Framing members transferring stresses, including those caused by thermal and structural movements to glazing.
    d. Noise or vibration created by thermal and structural movements.
    e. Loosening or weakening of fasteners, attachments, and other components.
    f. Failure of operating units.

B. Delegated Design: Design aluminum-framed systems, including comprehensive engineering analysis by a qualified North Carolina-registered professional engineer, using performance requirements and design criteria indicated.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For aluminum-framed systems. Include plans, elevations, sections, details, and attachments to other work.

1. Include details of provisions for system expansion and contraction and for drainage of moisture in the system to the exterior.

C. Samples: For each type of exposed finish required.

D. Delegated-Design Submittal: For aluminum-framed systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Warranties: Sample of special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Engineering Responsibility: Prepare data for aluminum-framed systems, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in systems similar to those indicated for this Project.

C. Accessible Entrances: Comply with applicable provisions in ICC/ANSI A117.1.

D. Source Limitations for Aluminum-Framed Systems: Obtain from single source from single manufacturer.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that fail in materials or workmanship within specified warranty period, including electrical components.

1. Warranty Period: Two years from date of Acceptance by Owner.

B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes do not comply with requirements or that fail in materials or workmanship within specified warranty period. Warranty does not include normal weathering.

1. Warranty Period: Five years from date of Acceptance by Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Automatic Door and Hardware Maverick Pro Automatic Sliding Doors, 508 Pat Booker Rd, Ste 450, Universal City, TX 78148, or comparable products by one of the following:

1. Stanley Access Technology.

2. Horton Automatics.

2.2 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

1. Sheet and Plate: ASTM B 209 (ASTM B 209M).
2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
3. Extruded Structural Pipe and Tubes: ASTM B 429.
4. Structural Profiles: ASTM B 308/B 308M.
5. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

B. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer, complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.

1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
2. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
3. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.3 FRAMING SYSTEMS

A. Framing Members: Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required for supporting imposed loads.

1. Construction: Non-thermal.
2. Glazing System: 1/4" Glass Stops (For 1/4" Glass).
3. Glazing Plane: Center.

B. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with non-staining, nonferrous shims for aligning system components.

C. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories compatible with adjacent materials.

1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
2. Reinforce members as required to receive fastener threads.

D. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts, complying with ASTM A 123/A 123M or ASTM A 153/A 153M.

E. Framing System Gaskets and Sealants: Manufacturer's standard, recommended by manufacturer for joint type.

2.4 GLAZING SYSTEMS

A. Glazing: As specified in Section 088000 "Glazing." Not part of this product.

B. Glazing Gaskets: Manufacturer's standard compression types; replaceable, molded or extruded, of profile and hardness required to maintain watertight seal. **Color shall be Grey.**

C. Spacers and Setting Blocks: Manufacturer's standard elastomeric type.

2.5 AUTOMATIC DOOR SYSTEMS

A. Full Breakout Design - All panels can break away in the event of an emergency

B. 5 position key switch with ON / OFF / REDUCED OPEN / HOLD OPEN / ONE WAY

C. Aluminum Header, 8-inches high by 6-inches deep, molded brushed DC One Motor operator with gear reduction assembly; Hardware to include a reinforced timing belt.

D. System to have a digital microprocessor control with built in diagnostics

E. 1-3/4" x 4-1/2" jambs

F. Narrow stiles on doors

G. Glass stops to accept 1/4" thick glass

H. System Monitored directional motion sensors and safety curtains. Sensors shall be microwave doppler radar for motion and active infrared with background analysis for presence.

I. 10" ADA bottom rail

J. Interlocking door panels with weather seal. Provide full breakout hardware

K. Mortise Hook Bolt Lock with keyed exterior and thumb turn cylinder on interior

L. Emergency breakaway hardware

M. No threshold

N. ANSI decals

O. Electrical Requirements: 120 VSC, 5 Amp.

2.6 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Provisions for field replacement of glazing.
6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

E. Header shall be self-supporting.

F. Opening size: 12-foot one half inch wide by 7-foot eight- and one-half inch high.

2.7 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure non-movement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
6. Seal joints watertight unless otherwise indicated.

B. Metal Protection:

1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or applying sealant or tape, or by installing nonconductive spacers as recommended by manufacturer for this purpose.
2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.

D. Set continuous sill members and flashing in full sealant bed as specified in Section 079200 "Joint Sealants" to produce weathertight installation.

E. Install components plumb and true in alignment with established lines and grades, and without warp or rack.

F. Install glazing as specified in Section 088000 "Glazing."

3.2 FIELD QUALITY CONTROL

A. Repair or remove work if inspections indicate that it does not comply with specified requirements.

1

2 END OF SECTION 084123

SECTION 084456 – ALUMINUM FLUSH -FRAMED CONCEALED DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Specialty concealed aluminum frames.

B. Related Sections:

   1. Section 054000, Cold-Formed Metal Framing.
   2. Section 061053, Miscellaneous Rough Carpentry.
   3. Section 092900, Gypsum Board.

1.2 PERFORMANCE REQUIREMENTS

A. General Performance: Aluminum-framed systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction:

   1. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
   2. Dimensional tolerances of building frame and other adjacent construction.
   3. Failure includes the following:

      a. Deflection exceeding specified limits.
      b. Thermal stresses transferring to building structure.
      c. Framing members transferring stresses, including those caused by thermal and structural movements to glazing.
      d. Noise or vibration created by thermal and structural movements.
      e. Loosening or weakening of fasteners, attachments, and other components.
      f. Failure of operating units.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For concealed aluminum-framed systems. Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each type of exposed finish required.

1.4 INFORMATIONAL SUBMITTALS

A. Warranties: Sample of special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that fail in materials or workmanship within specified warranty period, including electrical components.

1. Warranty Period: Two years from date of Acceptance by Owner.

B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes do not comply with requirements or that fail in materials or workmanship within specified warranty period. Warranty does not include normal weathering.

1. Warranty Period: Five years from date of Acceptance by Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following:

1. FlushDoorFrame.com.
2. AGS Systems, Model TCT45 (Basis-of-Design).
3. Equivalent product meeting the requirements of this specification

2.2 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

1. Sheet and Plate: ASTM B 209 (ASTM B 209M).
2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
3. Extruded Structural Pipe and Tubes: ASTM B 429.
4. Structural Profiles: ASTM B 308/B 308M.
5. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

B. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer, complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.

1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
2. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
3. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.3 FRAMING SYSTEMS

A. Framing Members: Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required for supporting imposed loads.

1. Construction: Non-thermal.

B. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories compatible with adjacent materials.

C. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts, complying with ASTM A 123/A 123M or ASTM A 153/A 153M.

2.4 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Framing Members, General: Fabricate components in raw untreated aluminum alloy EN EW-6060, for outswing doors without visible edge on the wall side, including support for the mesh to snap-in, corner connectors and bottom spreader bars to guaranty an easy assembly, moveable wall fixing brackets for a stable connection between frame and wall, mesh to snap-in to avoid wall cracking, incl. milling for striking plates and hinges according specifications.

D. Door leaf thickness: 44/45 - 56 mm

E. Opening size: refer to drawings at “Touch Tank”.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure non-movement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
6. Seal joints watertight unless otherwise indicated.

B. Metal Protection:

1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or applying sealant or tape, or by installing nonconductive spacers as recommended by manufacturer for this purpose.
2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.

D. Set continuous sill members and flashing in full sealant bed as specified in Section 079200 "Joint Sealants" to produce weathertight installation.

E. Install components plumb and true in alignment with established lines and grades, and without warp or rack.

F. Install glazing as specified in Section 088000 "Glazing."

3.2 FIELD QUALITY CONTROL

A. Repair or remove work if inspections indicate that it does not comply with specified requirements.

END OF SECTION 084456

SECTION 085800 - ALUMINUM BULLET RESISTANT TRANSACTION WINDOW

PART 1 – GENERAL

1.01 SUMMARY

A. This section includes:

1. Aluminum bullet resistant transaction windows as indicated in drawings and in sections.

1.02 SUBMITTALS

A. Product Data: Submit Manufacturer's technical product data substantiating that products comply.

B. Shop drawings: Submit for fabrication and installation of windows. Include details, elevations and installation requirement of finish hardware and cleaning.

C. Certification: Provide printed data in sufficient detail to indicate compliance with the contract documents.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Deliver windows crated to provide protection during transit and job storage

B. Inspect windows upon delivery for damage. Unless minor defects can be made to meet the Architect's specifications and satisfaction, damaged parts should be removed and replaced.

C. Store windows at building site under cover in dry location.

1.04 PROJECT CONDITIONS

A. Field measurements: Check opening by accurate field measurement before fabrication. Show recorded measurements on shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of work.

1.05 WARRANTY

A. All material and workmanship shall be warranted against defects for a period of one (1) year from the acceptance by Owner.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Basis of Design: Design is based on Model SUI-200-1 by Quikserv Inc., www.quikserv.com 11441 Brittmoore Park Dr. Houston, TX 77041

Equivalent products meeting the requirement of this specification will be acceptable.

2.02 MATERIALS

A. Unit Dimensions: 24" (w) x 48" (h) | Service opening: 20" (w) x 17-3/4" (h)

B. Finish: All aluminum to be clear anodized.

C. Glazing: 1/4-inch clear float, tempered.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install frames and glazing in accordance with manufacturer's printed instructions and recommendations. Repair damaged units as directed (if approved by the manufacturer and the architect) or replace with new units.

3.02 CLEANING

A. Clean frame and glazing surfaces after installation, complying with requirements contained in the manufacturer's instructions. Remove excess glazing sealant compounds, dirt or other substances.

3.03 PROTECTION

A. Institute protective measures required throughout the remainder of the construction period to ensure that all the windows do not incur any damage or deterioration, other than normal weathering, at the time of acceptance.

END OF SECTION 085800

SECTION 08 71 00 – DOOR HARDWARE

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Mechanical and electrified door hardware
2. Electronic access control system components
3. Field verification, preparation and modification of existing doors and frames to receive new door hardware.

B. Section excludes:

1. Windows
2. Cabinets (casework), including locks in cabinets
3. Signage
4. Toilet accessories
5. Overhead doors

C. Related Sections:

1. Division 01 "General Requirements" sections for Allowances, Alternates, Owner Furnished Contractor Installed, Project Management and Coordination.
2. Division 06 Section “Rough Carpentry”
3. Division 06 Section "Finish Carpentry”
4. Division 07 Section “Joint Sealants” for sealant requirements applicable to threshold installation specified in this section.
5. Division 08 Sections:
   a. "Metal Doors and Frames"
   b. "Flush Wood Doors"
   c. "Interior Aluminum Doors and Frames"
   d. "Aluminum-Framed Entrances and Storefronts"
   e. "Stainless Steel Doors and Frames"
   f. "Special Function Doors"
   g. "Entrances"
   h. 083919 – Watertight Doors
6. Division 26 “Electrical” sections for connections to electrical power system and for low-voltage wiring.
7. Division 28 “Electronic Safety and Security” sections for coordination with other components of electronic access control system and fire alarm system.

1.02 REFERENCES

A. UL, ULC

1. UL 10B - Fire Test of Door Assemblies
2. UL 10C - Positive Pressure Test of Fire Door Assemblies
3. UL 305 - Panic Hardware

B. DHI - Door and Hardware Institute

1. Sequence and Format for the Hardware Schedule
2. Recommended Locations for Builders Hardware
3. Keying Systems and Nomenclature
4. Installation Guide for Doors and Hardware

C. NFPA – National Fire Protection Association

1. NFPA 70 – National Electric Code
2. NFPA 80 – 2019 Edition – Standard for Fire Doors and Other Opening Protectives
3. NFPA 101 – Life Safety Code
4. NFPA 252 – Fire Tests of Door Assemblies

D. ANSI - American National Standards Institute

1. ANSI A117.1 – 2017 Edition – Accessible and Usable Buildings and Facilities
2. ANSI/BHMA A156.1 - A156.29, and ANSI/BHMA A156.31 - Standards for Hardware and Specialties
3. ANSI/BHMA A156.28 - Recommended Practices for Keying Systems
4. ANSI/WDMA I.S. 1A - Interior Architectural Wood Flush Doors
5. ANSI/SDI A250.8 - Standard Steel Doors and Frames

1.03 SUBMITTALS

A. General:

1. Submit in accordance with Conditions of Contract and Division 01 Submittal Procedures.
2. Prior to forwarding submittal:
   a. Comply with procedures for verifying existing door and frame compatibility for new hardware, as specified in PART 3, “EXAMINATION” article, herein.
   b. Review drawings and Sections from related trades to verify compatibility with specified hardware.
   c. Highlight, encircle, or otherwise specifically identify on submittals: deviations from Contract Documents, issues of incompatibility or other issues which may detrimentally affect the Work.

B. Action Submittals:

1. Product Data: Submit technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
2. Riser and Wiring Diagrams: After final approval of hardware schedule, submit details of electrified door hardware, indicating:
   a. Wiring Diagrams: For power, signal, and control wiring and including:
      1) Details of interface of electrified door hardware and building safety and security systems.
      2) Schematic diagram of systems that interface with electrified door hardware.
      3) Point-to-point wiring.
      4) Risers.

3. Samples for Verification: If requested by Architect, submit production sample of requested door hardware unit in finish indicated and tagged with full description for coordination with schedule.
   a. Samples will be returned to supplier. Units that are acceptable to Architect may, after final check of operations, be incorporated into Work, within limitations of key coordination requirements.

4. Door Hardware Schedule:
    a. Submit concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate fabrication of other work critical in Project construction schedule.
    b. Submit under direct supervision of a Door Hardware Institute (DHI) certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) with hardware sets in vertical format as illustrated by Sequence of Format for the Hardware Schedule published by DHI.
    c. Indicate complete designations of each item required for each opening, include:
        1) Door Index: door number, heading number, and Architect's hardware set number.
        2) Quantity, type, style, function, size, and finish of each hardware item.
        3) Name and manufacturer of each item.
        4) Fastenings and other pertinent information.
        5) Location of each hardware set cross-referenced to indications on Drawings.
        6) Explanation of all abbreviations, symbols, and codes contained in schedule.
        7) Mounting locations for hardware.
        8) Door and frame sizes and materials.
        9) Degree of door swing and handing.
        10) Operational Description of openings with electrified hardware covering egress, ingress (access), and fire/smoke alarm connections.

5. Key Schedule:
    a. After Keying Conference, provide keying schedule that includes levels of keying, explanations of key system's function, key symbols used, and door numbers controlled.
    b. Use ANSI/BHMA A156.28 "Recommended Practices for Keying Systems" as guideline for nomenclature, definitions, and approach for selecting optimal keying system.
    c. Provide 3 copies of keying schedule for review prepared and detailed in accordance with referenced DHI publication. Include schematic keying diagram and index each key to unique door designations.
    d. Index keying schedule by door number, keyset, hardware heading number, cross keying instructions, and special key stamping instructions.
    e. Provide one complete bitting list of key cuts and one key system schematic illustrating system usage and expansion. Forward bitting list, key cuts and key system schematic directly to Owner, by means as directed by Owner.
    f. Prepare key schedule by or under supervision of supplier, detailing Owner's final keying instructions for locks.

C. Informational Submittals:

1. Provide Qualification Data for Supplier, Installer and Architectural Hardware Consultant.
2. Provide Product Data:
    a. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.
    b. Include warranties for specified door hardware.

D. Closeout Submittals:

1. Operations and Maintenance Data: Provide in accordance with Division 01 and include:
    a. Complete information on care, maintenance, and adjustment; data on repair and replacement parts, and information on preservation of finishes.
    b. Catalog pages for each product.
    c. Final approved hardware schedule edited to reflect conditions as installed.

d. Final keying schedule
e. Copy of warranties including appropriate reference numbers for manufacturers to identify project.
f. As-installed wiring diagrams for each opening connected to power, both low voltage and 110 volts.

1.04 QUALITY ASSURANCE

A. Qualifications and Responsibilities:

1. Supplier: Recognized architectural hardware supplier with a minimum of 5 years documented experience supplying both mechanical and electromechanical door hardware similar in quantity, type, and quality to that indicated for this Project. Supplier to be recognized as a factory direct distributor by the manufacturer of the primary materials with a warehousing facility in the Project's vicinity. Supplier to have on staff, a certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) available to Owner, Architect, and Contractor, at reasonable times during the Work for consultation.
2. Installer: Qualified tradesperson skilled in the application of commercial grade hardware with experience installing door hardware similar in quantity, type, and quality as indicated for this Project.
3. Architectural Hardware Consultant: Person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and meets these requirements:
   a. For door hardware: DHI certified AHC or DHC.
   b. Can provide installation and technical data to Architect and other related subcontractors.
   c. Can inspect and verify components are in working order upon completion of installation.
   d. Capable of producing wiring diagram and coordinating installation of electrified hardware with Architect and electrical engineers.

4. Single Source Responsibility: Obtain each type of door hardware from single manufacturer.

B. Certifications:

1. Fire-Rated Door Openings:
   a. Provide door hardware for fire-rated openings that complies with NFPA 80 and requirements of authorities having jurisdiction.
   b. Provide only items of door hardware that are listed products tested by UL LLC, Intertek Testing Services, or other testing and inspecting organizations acceptable to authorities having jurisdiction for use on types and sizes of doors indicated, based on testing at positive pressure and according to NFPA 252 or UL 10C and in compliance with requirements of fire-rated door and door frame labels.

2. Electrified Door Hardware
   a. Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction.

3. Accessibility Requirements:
   a. Comply with governing accessibility regulations cited in "REFERENCES" article 087100, 1.02.D3 herein for door hardware on doors in an accessible route. This project must comply with all Federal Americans with Disability Act regulations and all Local Accessibility Regulations.

C. Pre-Installation Meetings

1. Keying Conference
   a. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including:
      1) Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
      2) Preliminary key system schematic diagram.
      3) Requirements for key control system.
      4) Requirements for access control.
      5) Address for delivery of keys.

2. Pre-installation Conference
   a. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   b. Inspect and discuss preparatory work performed by other trades.
   c. Inspect and discuss electrical roughing-in for electrified door hardware.
   d. Review sequence of operation for each type of electrified door hardware.
   e. Review required testing, inspecting, and certifying procedures.
   f. Review questions or concerns related to proper installation and adjustment of door hardware.

3. Electrified Hardware Coordination Conference:
   a. Prior to ordering electrified hardware, schedule and hold meeting to coordinate door hardware with security, electrical, doors and frames, and other related suppliers.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for hardware delivered to Project site. Promptly replace products damaged during shipping.

B. Tag each item or package separately with identification coordinated with final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package. Deliver each article of hardware in manufacturer's original packaging.

C. Maintain manufacturer-recommended environmental conditions throughout storage and installation periods.

D. Provide secure lock-up for door hardware delivered to Project. Control handling and installation of hardware items so that completion of Work will not be delayed by hardware losses both before and after installation.

E. Handle hardware in manner to avoid damage, marring, or scratching. Correct, replace or repair products damaged during Work. Protect products against malfunction due to paint, solvent, cleanser, or any chemical agent.

1.06 COORDINATION

A. Installation Templates: Distribute for doors, frames, and other work specified to be factory or shop prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

B. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.

C. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.

D. Existing Openings: Where existing doors, frames and/or hardware are to remain, field verify existing functions, conditions and preparations and coordinate to suit opening conditions and to provide proper door operation.

1.07 WARRANTY

A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within published warranty period.

1. Warranty does not cover damage or faulty operation due to improper installation, improper use or abuse.
2. Warranty Period: Beginning from date of Substantial Completion, for durations indicated in manufacturer's published listings.

a. Mechanical Warranty
   1) Locks
      a) 10 years
   2) Exit Devices
      a) 5 years
   3) Closers
      a) Surface: 30 years
      b) Concealed: 15 years
   4) Automatic Operators
      a) 2 years
   5) Overhead Stops
      a) 10 years

b. Electrical Warranty
    1) Locks
        a) 3 years
    2) Exit Devices
        a) 3 years
    3) Power Supplies
        a) 3 years

1.08 MAINTENANCE

A. Furnish complete set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.

B. Turn over unused materials to Owner for maintenance purposes.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Approval of alternate manufacturers and/or products other than those listed as “Scheduled Manufacturer” or “Acceptable Manufacturers” in the individual article for the product category are only to be considered by official substitution request in accordance in section 01 25 00.

B. Approval of products from manufacturers indicated in “Acceptable Manufacturers” is contingent upon those products providing all functions and features and meeting all requirements of scheduled manufacturer’s product.

C. Where specified hardware is not adaptable to finished shape or size of members requiring hardware, furnish suitable types having same operation and quality as type specified, subject to Architect's approval.

2.02 MATERIALS

A. Fabrication

1. Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. provide screws according to manufacturer’s recognized installation standards for application intended.
2. Finish exposed screws to match hardware finish, or, if exposed in surfaces of other work, to match finish of this other work including prepared for paint surfaces to receive painted finish.
3. Provide concealed fasteners wherever possible for hardware units exposed when door is closed. Coordinate with “Metal Doors and Frames”, “Flush Wood Doors”, “Stile and Rail Wood Doors” to ensure proper reinforcements. Advise the Architect where visible fasteners, such as thru bolts, are required.

B. Modification and Preparation of Existing Doors: Where existing door hardware is indicated to be removed and reinstalled.

1. Provide necessary fillers, Dutchmen, reinforcements, and fasteners, compatible with existing materials, as required for mounting new opening hardware and to cover existing door and frame preparations.
2. Use materials which match materials of adjacent modified areas.
3. When modifying existing fire-rated openings, provide materials permitted by NFPA 80 as required to maintain fire-rating.

C. Provide screws, bolts, expansion shields, drop plates and other devices necessary for hardware installation.

1. Where fasteners are exposed to view: Finish to match adjacent door hardware material.

D. Cable and Connectors:

1. Where scheduled in the hardware sets, provide each item of electrified hardware and wire harnesses with number and gage of wires enough to accommodate electric function of specified hardware.
2. Provide Molex connectors that plug directly into connectors from harnesses, electric locking and power transfer devices.
3. Provide through-door wire harness for each electrified locking device installed in a door and wire harness for each electrified hinge, electrified continuous hinge, electrified pivot, and electric power transfer for connection to power supplies.

2.03 HINGES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
   a. Ives 5BB series

2. Acceptable Manufacturers and Products:
   a. Hager BB1191/1279 series
   b. Best FBB series

B. Requirements:

1. Provide hinges conforming to ANSI/BHMA A156.1.
2. Provide five knuckle, ball bearing hinges.
3. Provide hinge weights and sizes as specified in hardware sets.
4. Adjust hinge width for door, frame, and wall conditions to allow proper degree of opening.
5. Provide three hinges per door leaf for doors 90 inches (2286 mm) or less in height, and one additional hinge for each 30 inches (762 mm) of additional door height.
6. Where new hinges are specified for existing doors or existing frames, provide new hinges of identical size to hinge preparation present in existing door or existing frame.
7. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
   a. Steel Hinges: Steel pins
   b. Non-Ferrous Hinges: Stainless steel pins
   c. Out-Swinging Exterior Doors: Non-removable pins
   d. Out-Swinging Interior Lockable Doors: Non-removable pins
   e. Interior Non-lockable Doors: Non-rising pins

8. Provide hinges with electrified options as scheduled in the hardware sets. Provide with number and gage of wires enough to accommodate electric function of specified hardware. Locate electric hinge at second hinge from bottom or nearest to electrified locking component. Provide mortar guard for each electrified hinge specified.

2.04 CONTINUOUS HINGES – ALUMINUM GEARED

A. Manufacturers:

1. Scheduled Manufacturer:
   a. Ives

2. Acceptable Manufacturers:
   a. Select
   b. ABH

B. Requirements:

1. Provide aluminum geared continuous hinges conforming to ANSI/BHMA A156.26, Grade 1.
2. Provide aluminum geared continuous hinges, where specified in the hardware sets, fabricated from 6063-T6 aluminum.
3. Provide split nylon bearings at each hinge knuckle for quiet, smooth, self-lubricating operation.
4. Provide hinges capable of supporting door weights up to 450 pounds, and successfully tested for 1,500,000 cycles.
5. On fire-rated doors, provide aluminum geared continuous hinges classified for use on rated doors by testing agency acceptable to authority having jurisdiction.
6. Provide aluminum geared continuous hinges with electrified option scheduled in the hardware sets. Provide with number and gage of wires enough to accommodate electric function of specified hardware.
7. Provide hinges 1 inch (25 mm) shorter in length than nominal height of door, unless otherwise noted or door details require shorter length and with symmetrical hole pattern.

2.05 CONTINUOUS HINGES – STAINLESS STEEL

A. Manufacturers:

1. Scheduled Manufacturer and Product:
   a. Ives 700 series

2. Acceptable Manufacturers:
   a. ABH
   b. Select

B. Requirements:

1. Provide pin and barrel continuous hinges conforming to ANSI/BHMA A156.26., Grade 1.
2. Provide pin and barrel continuous hinges fabricated from 14-gauge, type 304 stainless steel.
3. Provide twin self-lubricated nylon bearings at each hinge knuckle, with 0.25-inch (6 mm) diameter stainless steel pin.
4. Provide hinges capable of supporting door weights up to 600 pounds, and successfully tested for 1,500,000 cycles.
5. On fire-rated doors, provide pin and barrel continuous hinges classified for use on rated doors by testing agency acceptable to authority having jurisdiction.
6. Provide pin and barrel continuous hinges with electrified options as scheduled in the hardware sets. Provide with number and gage of wires enough to accommodate electric function of specified hardware.

7. Provide hinges 1 inch (25 mm) shorter in length than nominal height of door, unless otherwise noted or door details require shorter length and with symmetrical hole pattern.

2.06 ELECTRIC POWER TRANSFER

A. Manufacturers:

1. Scheduled Manufacturer and Product:
   a. Von Duprin EPT-10

2. Acceptable Manufacturers and Products:
   a. ABH PT1000
   b. Security Door Controls PTM

B. Requirements:

1. Provide power transfer with electrified options as scheduled in the hardware sets. Provide with number and gage of wires enough to accommodate electric function of specified hardware.
2. Locate electric power transfer per manufacturer's template and UL requirements, unless interference with operation of door or other hardware items.

2.07 FLUSH BOLTS

A. Manufacturers:

1. Scheduled Manufacturer:
   a. Ives

2. Acceptable Manufacturers:
   a. Burns
   b. DCI

B. Requirements:

1. Provide automatic, constant latching, and manual flush bolts with forged bronze or stainless-steel face plates, extruded brass levers, and with wrought brass guides and strikes. Provide 12 inch (305 mm) steel or brass rods at doors up to 90 inches (2286 mm) in height. For doors over 90 inches (2286 mm) in height increase top rods by 6 inches (152 mm) for each additional 6 inches (152 mm) of door height. Provide dust-proof strikes at each bottom flush bolt.

2.08 COORDINATORS

A. Manufacturers:

1. Scheduled Manufacturer:
   a. Ives

2. Acceptable Manufacturers:
   a. Trimco
   b. DCI

B. Requirements:

1. Where pairs of doors are equipped with automatic flush bolts, an astragal, or other hardware that requires synchronized closing of the doors, provide bar-type coordinating device, surface applied to underside of stop at frame head.
2. Provide filler bar of correct length for unit to span entire width of opening, and appropriate brackets for parallel arm door closers, surface vertical rod exit device strikes, or other stop mounted hardware. Factory-prepared coordinators for vertical rod devices as specified.

2.09 MORTISE LOCKS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
   a. Schlage L9000 series

2. Acceptable Manufacturers and Products:
   a. Sargent 8200 series
   b. Best 45H series

B. Requirements:

1. Provide mortise locks conforming to ANSI/BHMA A156.13 Series 1000, Grade 1, and UL Listed for 3-hour fire doors.
2. Indicators: Where specified, provide indicator window measuring a minimum 2-inch x 1/2 inch with 180-degree visibility. Provide messages color-coded with full text and/or symbols, as scheduled, for easy visibility.
3. Provide locks manufactured from heavy gauge steel, containing components of steel with a zinc dichromate plating for corrosion resistance.
4. Provide lock case that is multi-function and field reversible for handing without opening case. Cylinders: Refer to “KEYING” article, herein.
5. Provide locks with standard 2-3/4 inches (70 mm) backset with full 3/4 inch (19 mm) throw stainless steel mechanical anti-friction latchbolt. Provide deadbolt with full 1-inch (25 mm) throw, constructed of stainless steel.
6. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim.
7. Provide electrified options as scheduled in the hardware sets. Where scheduled, provide switches and sensors integrated into the locks and latches. Provide motor based electrified and motor-based latch retraction locksets that comply with the following requirements:
   a. Universal input voltage – single chassis accepts 12 or 24VDC to allow for changes in the field without changing lock chassis.
   b. Fail Safe/Fail Secure – changing mode between electrically locked (fail safe) and electrically unlocked (fail secure) is field selectable without opening the lock case
   c. Low maximum current draw – maximum 0.4 amps (Lever control) and maximum 2.0 amps (Latch retraction) to allow for multiple locks on a single power supply.
   d. Low holding current (Lever control or latch retraction) – maximum 0.01 amps to produce minimal heat, eliminate “hot levers” in electrically locked applications and motorized latch retraction applications, and to provide reliable operation in wood doors that provide minimal ventilation and air flow.
   e. Connections – provide quick-connect Molex system standard.

8. Lever Trim: Solid brass, bronze, or stainless steel, cast or forged in design specified, with wrought roses and external lever spring cages. Provide thru-bolted levers with 2-piece spindles.
   a. Lever Design: 03A.

2.10 EXIT DEVICES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
   a. Von Duprin 78/75A series

2. Acceptable Manufacturers and Products:
   a. Precision 2100 Series
   b. Falcon 25/24 Series

B. Requirements

1. Provide exit devices tested to ANSI/BHMA A156.3 Grade 1 and UL listed for Panic Exit or Fire Exit Hardware with manufacturer's approved strikes.
2. Cylinders: Refer to "KEYING" article, herein.
3. Provide exit devices with deadlatching feature for security and for future addition of alarm kits and/or other electrified requirements. No plastic inserts are allowed in touchpads.
4. Provide exit devices cut to door width and height. Install exit devices at height recommended by exit device manufacturer, allowable by governing building codes, and approved by Architect. Touchpad must extend a minimum of one half of door width.
5. Mount mechanism case flush on face of doors or provide spacers to fill gaps behind devices. Where glass trim or molding projects off face of door, provide glass bead kits.
6. Removable Mullions: 2 inches (51 mm) x 3 inches (76 mm) steel tube. Where scheduled as keyed removable mullion, provide type that can be removed by use of a keyed cylinder, which is self-locking when re-installed.
7. Provide factory drilled weep holes for exit devices used in full exterior application, highly corrosive areas, and where noted in hardware sets.
8. Provide electrified options as scheduled.
9. Top latch mounting: double- or single-tab mount for steel doors, face mount for aluminum doors eliminating requirement of tabs, and double tab mount for wood doors.
10. Provide exit devices with optional trim designs to match other lever and pull designs used on the project.

2.11 EXIT DEVICES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
   a. Von Duprin 98 series

2. Acceptable Manufacturers and Products:
   a. No Substitute

B. Requirements:

1. Provide exit devices tested to ANSI/BHMA A156.3 Grade 1 and UL listed for Panic Exit or Fire Exit Hardware.
2. Cylinders: Refer to "KEYING" article, herein.
3. Provide smooth touchpad type exit devices, fabricated of brass, bronze, stainless steel, or aluminum, plated to standard architectural finishes to match balance of door hardware.
4. Touchpad must extend a minimum of one half of door width. No plastic inserts are allowed in touchpads.
5. Provide exit devices with deadlatching feature for security and for future addition of alarm kits and/or other electrified requirements.
6. Provide exit devices with weather resistant components that can withstand harsh conditions of various climates and corrosive cleaners used in outdoor pool environments.
7. Provide flush end caps for exit devices.
8. Provide exit devices with manufacturer's approved strikes.

9. Provide exit devices cut to door width and height. Install exit devices at height recommended by exit device manufacturer, allowable by governing building codes, and approved by Architect.
10. Mount mechanism case flush on face of doors or provide spacers to fill gaps behind devices. Where glass trim or molding projects off face of door, provide glass bead kits.
11. Provide cylinder dogging as specified at non fire-rated openings.
12. Provide electrified options as scheduled.
13. Provide exit devices with optional trim designs to match other lever and pull designs used on the project.
14. Provide exit devices with PA filler.

2.12 ELECTRONIC ACCESS CONTROL WIRELESS MORTISE LOCK

A. Manufacturer and Products:

1. Scheduled Manufacturer and Product:
   a. Salto XS4 Original+

2. Acceptable Manufacturers and Products:
   a. No Substitute

B. Requirements: Provide wireless electronic locksets that comply with the following requirements.

1. Provide mortise locks conforming to ANSI/BHMA A156.13 Series 1000, Grade 1 Operational, Grade 1 Security at locks with interchangeable cores, and manufactured from heavy gauge steel, containing components of steel with a zinc dichromate plating for corrosion resistance. Cylinders: Refer to “KEYING” article, herein.
2. Provide heavy-duty, handed, field-reversible mortise locks.
3. Backset: 2-3/4-inch (70 mm).
4. Latchbolt: 3/4-inch (19 mm) throw stainless steel latch bolt with anti-friction tongue.
5. Deadbolt: 1” throw stainless steel deadbolt to support Privacy and Apartment functions.
6. Chassis: Provide standard A115.1 preparation for mortise locks for 1-3/4-inch (44 mm) doors.
7. Applicable Standards:
   a. Listed, UL 294 - Standard of Safety for Access Control System Units.
   b. Compliant with ANSI Standard A156.25 and A156.13 Series 1000, Grade 1 strength and operational requirements.
   c. Compliant with ANSI/BHMA A156.25 Grade 1 Operation and Security Requirement.
   d. Certified to UL10C, FCC Part15, IC RSS-210, ADA, RoHS, ICC ANSI A117.1
   e. Compliant with FBC TAS 201, TAS 202, TAS 203 for door assemblies.
   f. Certified to FBC 3905, 12400 and 14482
8. Lockset Functions: Provide locks in functions as specified in hardware groups.
9. Emergency Override: Provide mechanical key override; cylinders: Refer to “KEYING” article, herein.
10. Levers:
    a. Provide levers operating independently of each other.
    b. Lever Design: Salto ‘U’.
11. Power Supply:
    a. Provide lockset powered by four AA batteries

C. Provide Design XS ANSI wall readers at doors with electrified panic hardware.

1. Provide Salto smart access controllers with wall readers for complete installation.

2.13 POWER SUPPLIES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
   a. Schlage/Von Duprin PS900 Series

2. Acceptable Manufacturers and Products:
   a. Dynalock 5000 series
   b. Security Door Controls 600 series

B. Requirements:

1. Provide power supplies approved by manufacturer of supplied electrified hardware.
2. Provide appropriate quantity of power supplies necessary for proper operation of electrified locking components as recommended by manufacturer of electrified locking components with consideration for each electrified component using power supply, location of power supply, and approved wiring diagrams. Locate power supplies as directed by Architect.
3. Provide regulated and filtered 24 VDC power supply, and UL class 2 listed.
4. Provide power supplies with the following features:
   a. 12/24 VDC Output, field selectable.
   b. Class 2 Rated power limited output.
   c. Universal 120-240 VAC input.
   d. Low voltage DC, regulated and filtered.
   e. Polarized connector for distribution boards.
   f. Fused primary input.
   g. AC input and DC output monitoring circuit w/LED indicators.
   h. Cover mounted AC Input indication.
   i. Tested and certified to meet UL294.
   j. NEMA 1 enclosure.
   k. Hinged cover w/lock down screws.
   l. High voltage protective cover.

2.14 CYLINDERS

A. Manufacturers:

1. Scheduled Manufacturer and Product:
   a. Corbin-Russwin
   b. Acceptable Manufacturers and Products:
   c. No Substitute

B. Requirements:

1. Provide cylinders for locking devices, whether called out in hardware sets or not.
2. Provide large-format interchangeable cylinders/cores (LFIC) to match Owner’s existing Corbin-Russwin key system, with ‘L4’ keyway, compliant with ANSI/BHMA A156.5; latest revision; cylinder face finished to match lockset, manufacturer’s series as indicated. Refer to “KEYING” article, herein.

2.15 KEYING

A. Scheduled System:

1. Existing factory registered system:
   a. Provide cylinders/cores keyed into Owner's existing factory registered keying system. Comply with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.

B. Requirements:

1. Construction Keying:
   a. Replaceable Construction Cores.
      1) Provide temporary construction cores replaceable by permanent cores, furnished in accordance with the following requirements.
         a) 3 construction control keys
         b) 12 construction change (day) keys.
      2) Owner or Owner's Representative will replace temporary construction cores with permanent cores.

2. Permanent Keying:
   a. Provide permanent cylinders/cores keyed by the manufacturer according to the following key system.
      1) Master Keying system as directed by the Owner.
   b. Forward bitting list and keys separately from cylinders, by means as directed by Owner. Failure to comply with forwarding requirements will be cause for replacement of cylinders/cores involved at no additional cost to Owner.
   c. Provide keys with the following features:
      1) Material: Nickel silver; minimum thickness of .107-inch (2.3mm)
      2) Patent Protection: Keys and blanks protected by one or more utility patent(s).
   d. Identification:
      1) Mark permanent cylinders/cores and keys with applicable blind code for identification. Do not provide blind code marks with actual key cuts.
      2) Identification stamping provisions must be approved by the Architect and Owner.
      3) Stamp cylinders/cores and keys with Owner's unique key system facility code as established by the manufacturer; key symbol and embossed or stamped with "DO NOT DUPLICATE".
      4) Failure to comply with stamping requirements will be cause for replacement of keys involved at no additional cost to Owner.
      5) Forward permanent cylinders/cores to Owner, separately from keys, by means as directed by Owner.
   e. Quantity: Furnish in the following quantities.
      1) Change (Day) Keys: 3 per cylinder/core.
      2) Permanent Control Keys: 3.
      3) Master Keys: 6.

2.16 KEY CONTROL SYSTEM

A. Manufacturers:

1. Scheduled Manufacturer:
   a. Telkee

2. Acceptable Manufacturers:

a. HPC
b. Lund

B. Requirements:

1. Provide key control system, including envelopes, labels, tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet, all as recommended by system manufacturer, with capacity for 150% of number of locks required for Project.
   a. Provide complete cross index system set up by hardware supplier, and place keys on markers and hooks in cabinet as determined by final key schedule.
   b. Provide hinged-panel type cabinet for wall mounting.

2.17 DOOR CLOSERS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
   a. LCN 4040XP series

2. Acceptable Manufacturers and Products:
   a. Corbin-Russwin DC8000 series
   b. Sargent 281 series

B. Requirements:

1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory. ISO 9000 certify closers. Stamp units with date of manufacture code.
2. Provide door closers with fully hydraulic, full rack and pinion action with high strength cast iron cylinder, and full complement bearings at shaft.
3. Cylinder Body: 1-1/2-inch (38 mm) diameter piston with 5/8-inch (16 mm) diameter double heat-treated pinion journal. QR code with a direct link to maintenance instructions.
4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards. Provide snap-on cover clip, with plastic covers, that secures cover to spring tube.
6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and backcheck. Provide graphically labelled instructions on the closer body adjacent to each adjustment valve. Provide positive stop on reg valve that prevents reg screw from being backed out.
7. Provide closers with solid forged steel main arms and factory assembled heavy-duty forged forearms for parallel arm closers.
8. Pressure Relief Valve (PRV) Technology: Not permitted.
9. Finish for Closer Cylinders, Arms, Adapter Plates, and Metal Covers: Powder coating finish which has been certified to exceed 100 hours salt spray testing as described in ANSI Standard A156.4 and ASTM B117, and has special rust inhibitor (SRI).
10. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

11. Provide closers capable of being upgraded by adding modular mechanical or electronic components in the field.

2.18 CONCEALED DOOR CLOSERS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
   a. LCN 2030 series

B. Requirements:

1. Provide concealed door closers at doors conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory.
2. Provide heavy duty, single-acting closers with single lever arm and roller assembly.
3. Provide closers capable of being mounted in a minimum 1-3/4-inch header.
4. Provide concealed door closers with fully hydraulic, full rack and pinion action with high strength cast iron cylinder, and full complement bearings at shaft.
5. Cylinder Body: 1-1/8-inch (29 mm) piston diameter, with 5/8-inch (16 mm) diameter heat-treated pinion journal.
6. Provide all-weather hydraulic fluid, fireproof, passing requirements of UL10C.
7. Pressure Relief Valve (PRV) Technology: Not permitted.
8. Provide special template, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

2.19 ELECTRO-HYDRAULIC AUTOMATIC OPERATORS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
   a. LCN 4600 series

2. Acceptable Manufacturers and Products:
   a. Precision D4990 series
   b. Besam Power Swing

B. Requirements:

1. Provide low energy automatic operator units with hydraulic closer complying with ANSI/BHMA A156.19.
2. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
3. Provide units with conventional door closer opening and closing forces unless power operator motor is activated. Provide door closer assembly with adjustable spring size, back-check, and opening and closing speed adjustment valves to control door
4. Provide units with on/off switch for manual operation, motor start up delay, vestibule interface delay, electric lock delay, and door hold open delay.
5. Provide drop plates, brackets, and adapters for arms as required for details.
6. Provide hard-wired actuator switches and receivers for operation as specified.
7. Provide weather-resistant actuators at exterior applications.

8. Provide key switches with LED's, recommended and approved by manufacturer of automatic operator as required for function described in operation description of hardware group below. Cylinders: Refer to "KEYING" article, herein.
9. Provide complete assemblies of controls, switches, power supplies, relays, and parts/material recommended and approved by manufacturer of automatic operator for each individual leaf. Actuators control both doors simultaneously at pairs. Sequence operation of exterior and vestibule doors with automatic operators to allow ingress or egress through both sets of openings as directed by Architect. Locate actuators, key switches, and other controls as directed by Architect.
10. Provide units with vestibule inputs that allow sequencing operation of two units, and SPDT relay for interfacing with latching or locking devices.

2.20 DOOR TRIM

A. Manufacturers:

1. Scheduled Manufacturer:
   a. Ives.

2. Acceptable Manufacturers:
   a. Trimco
   b. Burns

B. Requirements:

1. Provide push plates, push bars, pull plates, pulls, and hands-free reversible door pulls with diameter and length as scheduled.

2.21 PROTECTION PLATES

A. Manufacturers:

1. Scheduled Manufacturer:
   a. Ives

2. Acceptable Manufacturers:
   a. Burns
   b. Trimco

B. Requirements:

1. Provide protection plates with a minimum of 0.050 inch (1 mm) thick, beveled four edges as scheduled. Furnish with sheet metal or wood screws, finished to match plates.
2. Provide protection plates with countersunk screw holes.
3. Sizes plates 2 inches (51 mm) less width of door on single doors, pairs of doors with a mullion, and doors with edge guards. Size plates 1 inch (25 mm) less width of door on pairs without a mullion or edge guards.
4. At fire rated doors, provide protection plates over 16 inches high with UL label.

2.22 OVERHEAD STOPS AND OVERHEAD STOP/HOLDERS

A. Manufacturers:

1. Scheduled Manufacturers:
   a. Glynn-Johnson

2. Acceptable Manufacturers:
   a. Rixson
   b. ABH

B. Requirements:

1. Provide overhead stop at any door where conditions do not allow for a wall stop or floor stop presents tripping hazard.
2. Provide friction type at doors without closer and positive type at doors with closer.

2.23 DOOR STOPS AND HOLDERS

A. Manufacturers:

1. Scheduled Manufacturer:
   a. Ives

2. Acceptable Manufacturers:
   a. Trimco
   b. Burns

B. Provide door stops at each door leaf:

1. Provide wall stops wherever possible. Provide concave type where lockset has a push button or thumbturn.
2. Where a wall stop cannot be used, provide an overhead stop.
3. Where wall or overhead stop cannot be used, provide floor stop.
4. Provide roller bumper where doors open into each other and overhead stop cannot be used.

2.24 THRESHOLDS, SEALS, DOOR SWEEPS, AUTOMATIC DOOR BOTTOMS, AND GASKETING

A. Manufacturers:

1. Scheduled Manufacturer:
   a. Zero International

2. Acceptable Manufacturers:
   a. National Guard
   b. Reese

B. Requirements:

1. Provide thresholds, weather-stripping, and gasketing systems as specified and per architectural details. Match finish of other items.
2. Provide door sweeps, seals, astragals, and auto door bottoms only of type where resilient or flexible seal strip is easily replaceable and readily available.
3. Size thresholds 1/2 inch (13 mm) high by 5 inches (127 mm) wide by door width unless otherwise specified in the hardware sets or detailed in the drawings.

4. At doors indicated to receive thermally-broken door frames, provide thermally-broken type thresholds.

2.25 ROLLER LATCHES

A. Manufacturers:

1. Scheduled Manufacturer:
   a. Ives

2. Acceptable Manufacturers:
   a. Burns
   b. Trimco

B. Requirements:

1. Provide roller latches with 4-7/8 inches (124 mm) strike at single doors to fit ANSI frame prep. If dummy levers are used in conjunction with roller latch mount roller latch at a height as to not interfere with proper mounting and height of dummy lever.
2. Provide roller latches with 2-1/4 inches (57 mm) full lip strike at pair doors. Mount roller in top rail of each leaf per manufacturer's template.

2.26 DOOR POSITION SWITCHES

A. Manufacturers:

1. Scheduled Manufacturer:
   a. Schlage

2. Acceptable Manufacturers:
   a. GE-Interlogix
   b. Sentrol

B. Requirements:

1. Provide recessed or surface mounted type door position switches as specified.
2. Coordinate door and frame preparations with door and frame suppliers. If switches are being used with magnetic locking device, provide minimum of 4 inches (102 mm) between switch and magnetic locking device.

2.27 COAT HOOKS

A. Manufacturers:

1. Scheduled Manufacturer:
   a. Ives

2. Acceptable Manufacturers:
   a. Burns
   b. Trimco

B. Provide coat hooks as specified.

2.28 FINISHES

A. Finish: Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Prior to installation of hardware, examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance. Verify doors, frames, and walls have been properly reinforced for hardware installation.

B. Field verify existing doors and frames receiving new hardware and existing conditions receiving new openings. Verify that new hardware is compatible with existing door and frame preparation and existing conditions.

C. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

D. Submit a list of deficiencies in writing and proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Where on-site modification of doors and frames is required:

1. Carefully remove existing door hardware and components being reused. Clean, protect, tag, and store in accordance with storage and handling requirements specified herein.
2. Field modify and prepare existing doors and frames for new hardware being installed.
3. When modifications are exposed to view, use concealed fasteners, when possible.
4. Prepare hardware locations and reinstall in accordance with installation requirements for new door hardware and with:
    a. Steel Doors and Frames: For surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.
    b. Wood Doors: DHI WDHS.5 "Recommended Hardware Reinforcement Locations for Mineral Core Wood Flush Doors."
    c. Doors in rated assemblies: Comply with NFPA 80 for restrictions regarding on-site door hardware preparation.

3.03 INSTALLATION

A. Mount door hardware units at heights to comply with the following, unless otherwise indicated or required to comply with governing regulations.

1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
2. Custom Steel Doors and Frames: HMMA 831.
3. Interior Architectural Wood Flush Doors: ANSI/WDMA I.S. 1A
4. Installation Guide for Doors and Hardware: DHI TDH-007-20

B. Install door hardware in accordance with NFPA 80, NFPA 101 and provide post-install inspection, testing as specified in section 1.03.E unless otherwise required to comply with governing regulations.

C. Install each hardware item in compliance with manufacturer's instructions and recommendations, using only fasteners provided by manufacturer.

D. Do not install surface mounted items until finishes have been completed on substrate. Protect all installed hardware during painting.

E. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.

F. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

G. Install operating parts so they move freely and smoothly without binding, sticking, or excessive clearance.

H. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than quantity recommended by manufacturer for application indicated.

I. Lock Cylinders:

1. Install construction cores to secure building and areas during construction period.
2. Replace construction cores with permanent cores as indicated in keying section.
3. Furnish permanent cores to Owner for installation.

J. Wiring: Coordinate with Division 26, ELECTRICAL and Division 28 ELECTRONIC SAFETY AND SECURITY sections for:

1. Conduit, junction boxes and wire pulls.
2. Connections to and from power supplies to electrified hardware.
3. Connections to fire/smoke alarm system and smoke evacuation system.
4. Connection of wire to door position switches and wire runs to central room or area, as directed by Architect.
5. Connections to panel interface modules, controllers, and gateways.
6. Testing and labeling wires with Architect's opening number.

K. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.

L. Continuous Hinges: Re-locate the door and frame fire rating labels where they will remain visible so that the hinge does not cover the label once installed.

M. Door Closers & Auto Operators: Mount closers/operators on room side of corridor doors, inside of exterior doors, and stair side of stairway doors from corridors. Mount closers/operators so they are not visible in corridors, lobbies and other public spaces unless approved by Architect.

N. Overhead Stops/Holders: Mount overhead stops/holders on room side of corridor doors, inside of exterior doors, and stair side of stairway doors.

O. Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings or in equipment room, or alternate location as directed by Architect.

P. Thresholds: Set thresholds in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."

Q. Stops: Do not mount floor stops where they may impede traffic or present tripping hazard.

R. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

S. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

T. Door Bottoms and Sweeps: Apply to bottom of door, forming seal with threshold when door is closed.

3.04 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

B. Occupancy Adjustment: Approximately three to six months after date of Substantial Completion, examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors and door hardware.

3.05 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items per manufacturer’s instructions to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

3.06 DOOR HARDWARE SCHEDULE

A. The intent of the hardware specification is to specify the hardware for interior and exterior doors, and to establish a type, continuity, and standard of quality. However, it is the door hardware supplier's responsibility to thoroughly review existing conditions, schedules, specifications, drawings, and other Contract Documents to verify the suitability of the hardware specified.

B. Discrepancies, conflicting hardware, and missing items are to be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application.

C. Hardware items are referenced in the following hardware schedule. Refer to the above specifications for special features, options, cylinders/keying, and other requirements.

D. Hardware Sets:

HARDWARE GROUP NO. 01

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1		EXISTING DOOR	EXISTING HARDWARE TO REMAIN.		

HARDWARE GROUP NO. 02

Provide each SL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
		NOTE	BALANCE OF HARDWARE BY DOOR SUPPLIER		

HARDWARE GROUP NO. 03

Provide each RU door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
		NOTE	HARDWARE BY DOOR SUPPLIER		

HARDWARE GROUP NO. 04

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	224XY	628	IVE
2	EA	ROLLER LATCH	RL32	626	IVE
2	EA	HALF DUMMY TRIM	L0170 03A	630	SCH
2	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

HARDWARE GROUP NO. 05

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	630	IVE
1	EA	PASSAGE SET	L9010 03A	630	SCH
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

HARDWARE GROUP NO. 06

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	041XY	628	IVE
1	EA	CLASSROOM LOCK	L9070L 03A	630	SCH
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

HARDWARE GROUP NO. 07

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	630	IVE
1	EA	STOREROOM LOCK	L9080L 03A	630	SCH
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

HARDWARE GROUP NO. 08

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	224XY	628	IVE
1	EA	PUSH/PULL BAR	9190EZHD-10"-NS	US32D-316	IVE
1	EA	SURF. AUTO OPERATOR	4642 WMS 120 VAC	689	LCN
2	EA	ACTUATOR, TOUCHLESS	8310-813		LCN
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND UNLOCKED. PUSH/PULL OPERATION, EITHER MANUALLY, OR AUTOMATICALLY USING WALL-MOUNTED WAVE ACTUATOR FROM INSIDE OR OUTSIDE.

HARDWARE GROUP NO. 09

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP	630	IVE
1	EA	STOREROOM LOCK	L9080L 03A	630	SCH
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	OH STOP	90S	630	GLY
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

HARDWARE GROUP NO. 10

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	224XY	628	IVE
1	EA	STOREROOM LOCK	L9080L 03A	630	SCH
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	OH STOP	90S	630	GLY

HARDWARE GROUP NO. 11

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	224XY	628	IVE
1	EA	STOREROOM LOCK	L9080L 03A	630	SCH
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

HARDWARE GROUP NO. 12

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	630	IVE
1	EA	PASSAGE SET	L9010 03A	630	SCH
1	EA	OH STOP	450S	630	GLY

HARDWARE GROUP NO. 13

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	224XY	628	IVE
1	EA	CONST LATCHING BOLT	FB51P	630	IVE
1	EA	DUST PROOF STRIKE	DP1	626	IVE
1	EA	CLASSROOM LOCK	L9070L 03A	630	SCH
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
2	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	MEETING STILE	383AA	AA	ZER
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

HARDWARE GROUP NO. 14

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	041XY	628	IVE
1	EA	CONST LATCHING BOLT	FB51P	630	IVE
1	EA	DUST PROOF STRIKE	DP1	626	IVE
1	EA	CLASSROOM LOCK	L9070L 03A	630	SCH
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
2	EA	OH STOP	100S	630	GLY
1	EA	MEETING STILE	383AA	AA	ZER
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

HARDWARE GROUP NO. 15

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HINGE	5BB1 4.5 X 4.5 NRP	630	IVE
2	EA	MANUAL FLUSH BOLT	FB458	626	IVE
1	EA	DUST PROOF STRIKE	DP1	626	IVE
1	EA	STOREROOM LOCK	L9080L 03A	630	SCH
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
2	EA	OH STOP	90S	630	GLY
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
1	EA	MEETING STILE	383AA	AA	ZER
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

HARDWARE GROUP NO. 16

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	224XY	628	IVE
2	EA	MANUAL FLUSH BOLT	FB458	626	IVE
1	EA	DUST PROOF STRIKE	DP1	626	IVE
1	EA	STOREROOM LOCK	L9080L 03A	630	SCH
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
2	EA	OH STOP	90S	630	GLY
1	EA	MEETING STILE	383AA	AA	ZER
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

HARDWARE GROUP NO. 17

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	630	IVE
1	EA	PRIVACY LOCK W/ OUTSIDE INDICATOR	L9040 03A L583-363 OS-OCC	630	SCH
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ SRI WMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	SINGLE HOOK	507B	626	IVE

HARDWARE GROUP NO. 18

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	630	IVE
1	EA	PRIVACY LOCK W/ OUTSIDE INDICATOR	L9040 03A L583-363 OS-OCC	630	SCH
1	EA	OH STOP	100S	630	GLY
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ SRI WMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	MOP PLATE	8400 4" X 1" LDW B-CS	630	IVE
1	EA	SINGLE HOOK	507B	626	IVE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

HARDWARE GROUP NO. 19

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	224XY	628	IVE
1	EA	PRIVACY LOCK W/ OUTSIDE INDICATOR	L9040 03A L583-363 OS-OCC	630	SCH
1	EA	OH STOP	100S	630	GLY
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ SRI WMS	689	LCN
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	545A	A	ZER
1	EA	SINGLE HOOK	507B	626	IVE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

HARDWARE GROUP NO. 20

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	224XY	628	IVE
1	EA	PRIVACY LOCK W/ OUTSIDE INDICATOR	L9040 03A L583-363 OS-OCC	630	SCH
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ SRI WMS	689	LCN
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	SINGLE HOOK	507B	626	IVE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

HARDWARE GROUP NO. 21

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	630	IVE
1	EA	CLASSROOM LOCK	L9070L 03A	630	SCH
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ SRI WMS	689	LCN
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

HARDWARE GROUP NO. 22

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	630	IVE
1	EA	CLASSROOM LOCK	L9070L 03A	630	SCH
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	SURFACE CLOSER	4040XP SRI WMS	689	LCN
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	DOOR BOTTOM	369AA	AA	ZER
1	EA	THRESHOLD	63A-223	A	ZER
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

HARDWARE GROUP NO. 23

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	630	IVE
1	EA	STOREROOM LOCK	L9080L 03A	630	SCH
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ SRI WMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE

Operational Description: Door normally closed and locked. Access by key from outside. Inside lever always free for egress.

HARDWARE GROUP NO. 24

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	630	IVE
1	EA	FIRE EXIT HARDWARE	78-L-BE-F-03	630	VON
1	EA	SURFACE CLOSER	4040XP EDA SRI	689	LCN
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

HARDWARE GROUP NO. 25

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	224XY	628	IVE
1	EA	FIRE EXIT HARDWARE	78-L-F-03	630	VON
1	EA	RIM CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	SURFACE CLOSER	4040XP EDA SRI	689	LCN
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

HARDWARE GROUP NO. 26

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP	630	IVE
1	EA	PANIC HARDWARE	CD-78-NL	630	VON
1	EA	RIM CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	SURFACE CLOSER	4040XP EDA SRI	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

HARDWARE GROUP NO. 27

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	224XY	628	IVE
1	EA	PANIC HARDWARE	LD-78-NL	630	VON
1	EA	RIM CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	SURFACE CLOSER	4040XP EDA SRI	689	LCN
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

HARDWARE GROUP NO. 28

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	224XY	628	IVE
1	EA	CONST LATCHING BOLT	FB51P	630	IVE
1	EA	DUST PROOF STRIKE	DP1	626	IVE
1	EA	FIRE EXIT HARDWARE	78-NL-F	630	VON
1	EA	RIM CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	COORDINATOR	COR X FL	US26D	IVE
2	EA	SURFACE CLOSER	4040XP CUSH SRI	689	LCN
1	EA	MEETING STILE	383AA	AA	ZER
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

HARDWARE GROUP NO. 29

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	630	IVE
1	EA	PUSH PLATE	8200 6" X 16"	630	IVE
1	EA	PULL PLATE	8303 10" 4" X 16"	630	IVE
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ SRI	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	MOP PLATE	8400 4" X 1" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

Operational Description: Doors normally closed and unlocked. Push/pull operation.

HARDWARE GROUP NO. 30

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	224XY	628	IVE
1	EA	PUSH PLATE	8200 6" X 16"	630	IVE
1	EA	PULL PLATE	8303 10" 4" X 16"	630	IVE
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ SRI	689	LCN
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	545A	A	ZER
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

OPERATIONAL DESCRIPTION: DOORS NORMALLY CLOSED AND UNLOCKED. PUSH/PULL OPERATION.

HARDWARE GROUP NO. 31

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	224XY EPT	628	IVE
1	EA	POWER TRANSFER	EPT10	689	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-75-NL-OP-388-CON 24 VDC	626	VON
1	EA	RIM CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	LONG DOOR PULL	9264F 24" A	630-316	IVE
1	EA	OH STOP	100S	630	GLY
1	EA	SURF. AUTO OPERATOR	4642 WMS 120 VAC	689	LCN
2	EA	ACTUATOR, TOUCHLESS	8310-813		LCN
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	625A-223	A	ZER
1	EA	WIRE HARNESS	CON-6W		SCH
1	EA	WIRE HARNESS	CON-XX-P LENGTH AS REQUIRED FOR USE WITH DOOR		SCH
1	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	POWER SUPPLY	PS902 BBK 900-2RS KL900 120/240 VAC	LGR	SCE
1	SET	WIRING DIAGRAMS	DOOR ELEVATION AND POINT-TO-POINT		SCE
			CARD READER BY OTHERS		
			SEALS BY DOOR SUPPLIER		

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. AUTHORIZED ACCESS BY VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCH AND RETRACTS LATCH BOLT, ALLOWING DOOR TO BE PULLED OPEN MANUALLY, OR AUTOMATICALLY BY OUTSIDE WAVE ACTUATOR. IMMEDIATE EGRESS ALWAYS ALLOWED MANUALLY BY DEPRESSING EXIT DEVICE PUSH RAIL, WHICH SHUNTS DOOR POSITION SWITCH (REX) AND RETRACTS LATCH BOLT, OR AUTOMATICALLY BY INSIDE WAVE ACTUATOR, WHICH RETRACTS EXIT DEVICE LATCHBOLT, AND AUTOMATICALLY OPENS THE DOOR.

HARDWARE GROUP NO. 32

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	224XY EPT	628	IVE
1	EA	POWER TRANSFER	EPT10	689	VON
1	EA	ELEC PANIC HARDWARE	CD-RX-75-EO-CON	626	VON
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	LONG DOOR PULL	9264F 24" A	630-316	IVE
1	EA	CONCEALED CLOSER	2034 BUMP SRI WMS	689	LCN
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	625A-223	A	ZER
1	EA	WIRE HARNESS	CON-XX-P LENGTH AS REQUIRED FOR USE WITH DOOR		SCH
1	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	SET	WIRING DIAGRAMS	DOOR ELEVATION AND POINT-TO-POINT		SCE
			SEALS BY DOOR SUPPLIER		

DOOR MONITORED FOR SECURITY. REQUEST TO EXIT (REX) SWITCH IN PUSH RAIL SHUNTS DOOR POSITION SWITCH.

HARDWARE GROUP NO. 33

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	224XY	628	IVE
1	EA	PUSH BAR	9100HD-A	630	IVE
1	EA	LONG DOOR PULL	9264F 24" A	630-316	IVE
1	EA	CONCEALED CLOSER	2034 BUMP SRI WMS	689	LCN
			SEALS BY DOOR SUPPLIER		

HARDWARE GROUP NO. 34

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	224XY	628	IVE
1	EA	PUSH BAR	9100HD-A	630	IVE
1	EA	LONG DOOR PULL	9264F 24" A	630-316	IVE
1	EA	OH STOP	100S	630	GLY
1	EA	SURF. AUTO OPERATOR	4642 WMS 120 VAC	689	LCN
2	EA	ACTUATOR, TOUCHLESS	8310-813		LCN
			SEALS BY DOOR SUPPLIER		

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND UNLATCHED. DOOR CAN BE OPENED EITHER MANUALLY BY PUSH/PULL, OR AUTOMATICALLY BY INSIDE OR OUTSIDE WAVE ACTUATORS.

HARDWARE GROUP NO. 35

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	630	IVE
1	EA	WIRELESS ACCESS CONTROL LOCK	BY OTHERS	630	SAL
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ SRI WMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. ACCESS BY KEY, OR VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCH AND MOMENTARILY UNLOCKS OUTSIDE LEVER. INSIDE LEVER ALWAYS FREE FOR EGRESS. OPERATING INSIDE LEVER SHUNTS DOOR POSITION SWITCH FOR REQUEST TO EXIT (REX).

HARDWARE GROUP NO. 36

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	224XY	628	IVE
1	EA	WIRELESS ACCESS CONTROL LOCK	BY OTHERS	630	SAL
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	OH STOP	100S	630	GLY
1	EA	SURFACE CLOSER	4040XP SRI TBWMS 1 3/4"	689	LCN
1	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. ACCESS BY KEY, OR VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCH AND MOMENTARILY UNLOCKS OUTSIDE LEVER. INSIDE LEVER ALWAYS FREE FOR EGRESS. OPERATING INSIDE LEVER SHUNTS DOOR POSITION SWITCH FOR REQUEST TO EXIT (REX).

HARDWARE GROUP NO. 37

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP	630	IVE
1	EA	WIRELESS ACCESS CONTROL LOCK	BY OTHERS	630	SAL
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	SURFACE CLOSER	4040XP EDA SRI TBWMS 1 3/4"	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. ACCESS BY KEY, OR VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCH AND MOMENTARILY UNLOCKS OUTSIDE LEVER. INSIDE LEVER ALWAYS FREE FOR EGRESS. OPERATING INSIDE LEVER SHUNTS DOOR POSITION SWITCH FOR REQUEST TO EXIT (REX).

HARDWARE GROUP NO. 38

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP	630	IVE
1	EA	WIRELESS ACCESS CONTROL LOCK	BY OTHERS	630	SAL
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	SURFACE CLOSER	4040XP CUSH SRI TBWMS 1 3/4"	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		
1			CARD READER BY OTHERS		

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. ACCESS BY KEY, OR VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCH AND MOMENTARILY UNLOCKS OUTSIDE LEVER. INSIDE LEVER ALWAYS FREE FOR EGRESS. OPERATING INSIDE LEVER SHUNTS DOOR POSITION SWITCH FOR REQUEST TO EXIT (REX).

HARDWARE GROUP NO. 39

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP	630	IVE
1	EA	WIRELESS ACCESS CONTROL LOCK	BY OTHERS	630	SAL
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	COAT AND HAT HOOK	507	626	IVE
1	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. ACCESS BY KEY, OR VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCH AND MOMENTARILY UNLOCKS OUTSIDE LEVER. INSIDE LEVER ALWAYS FREE FOR EGRESS. OPERATING INSIDE LEVER SHUNTS DOOR POSITION SWITCH FOR REQUEST TO EXIT (REX).

HARDWARE GROUP NO. 40

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	224XY	628	IVE
1	EA	WIRELESS ACCESS CONTROL LOCK	BY OTHERS	630	SAL
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	SURFACE CLOSER	4040XP EDA SRI TBWMS 1 3/4"	689	LCN
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. ACCESS BY KEY, OR VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCH AND MOMENTARILY UNLOCKS OUTSIDE LEVER. INSIDE LEVER ALWAYS FREE FOR EGRESS. OPERATING INSIDE LEVER SHUNTS DOOR POSITION SWITCH FOR REQUEST TO EXIT (REX).

HARDWARE GROUP NO. 41

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	224XY	628	IVE
1	EA	WIRELESS ACCESS CONTROL LOCK	BY OTHERS	630	SAL
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	SURFACE CLOSER	4040XP HCUSH SRI TBWMS 1 3/4"	689	LCN
1	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. ACCESS BY KEY, OR VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCH AND MOMENTARILY UNLOCKS OUTSIDE LEVER. INSIDE LEVER ALWAYS FREE FOR EGRESS. OPERATING INSIDE LEVER SHUNTS DOOR POSITION SWITCH FOR REQUEST TO EXIT (REX).

HARDWARE GROUP NO. 42

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	224XY	628	IVE
1	EA	WIRELESS ACCESS CONTROL LOCK	BY OTHERS	630	SAL
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	SURFACE CLOSER	4040XP SHCUSH SRI TBWMS 1 3/4"	689	LCN
1	EA	RAIN DRIP	142AA	AA	ZER
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	625A-223	A	ZER
1	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. ACCESS BY KEY, OR VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCH AND MOMENTARILY UNLOCKS OUTSIDE LEVER. INSIDE LEVER ALWAYS FREE FOR EGRESS. OPERATING INSIDE LEVER SHUNTS DOOR POSITION SWITCH FOR REQUEST TO EXIT (REX).

HARDWARE GROUP NO. 43

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	224XY	628	IVE
1	EA	WIRELESS ACCESS CONTROL LOCK	BY OTHERS	630	SAL
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ SRI WMS	689	LCN
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. ACCESS BY KEY, OR VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCH AND MOMENTARILY UNLOCKS OUTSIDE LEVER. INSIDE LEVER ALWAYS FREE FOR EGRESS. OPERATING INSIDE LEVER SHUNTS DOOR POSITION SWITCH FOR REQUEST TO EXIT (REX).

HARDWARE GROUP NO. 44

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	224XY EPT	628	IVE
1	EA	POWER TRANSFER	EPT10	689	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-75-NL-OP-388-CON 24 VDC	626	VON
1	EA	RIM CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	90 DEG OFFSET PULL	8190EZHD 10" O	630-316	IVE
1	EA	SURFACE CLOSER	4040XP EDA SRI	689	LCN
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	WIRE HARNESS	CON-6W		SCH
1	EA	WIRE HARNESS	CON-XX-P LENGTH AS REQUIRED FOR USE WITH DOOR		SCH
1	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	POWER SUPPLY	PS902 BBK 900-4RL KL900 120/240 VAC	LGR	SCE
1	SET	WIRING DIAGRAMS	DOOR ELEVATION AND POINT-TO-POINT		SCE
			CARD READER BY OTHERS		
			SEALS BY DOOR SUPPLIER		

OPERATIONAL DESCRIPTION:
IMMEDIATE EGRESS ALWAYS ALLOWED.
ESL SWITCH IN EXIT DEVICE RAIL TO RETRACT AND HOLD EXIT DEVICE LATCHBOLT AND ENABLE EXTERIOR AUTOMATIC OPERATOR ACTUATOR.
DOOR CAN BE MANUALLY PULLED OPEN OR AUTOMATICALLY OPERATED BY EXTERIOR OR INTERIOR ACTUATOR, WHICH SIGNALS AUTOMATIC OPERATOR TO OPEN DOOR.

SECURE OPERATION:
ESL SWITCH IN EXIT DEVICE RAIL TO RELEASE EXIT DEVICE LATCHBOLT AND DISABLE EXTERIOR ACTUATOR TO CONTROL ENTRY. ACCESS BY KEY ONLY.
IMMEDIATE EGRESS ALWAYS ALLOWED.
AUTOMATIC OPERATION BY INTERIOR ACTUATOR WHICH WILL RETRACT EXIT DEVICE LATCHBOLT MOMENTARILY THEN SIGNAL AUTOMATIC OPERATOR TO OPEN DOOR.

HARDWARE GROUP NO. 45

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5	630	IVE
1	EA	WIRELESS ACCESS CONTROL LOCK	BY OTHERS	630	SAL
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	COAT AND HAT HOOK	507	626	IVE
1	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. ACCESS BY KEY, OR VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCH AND MOMENTARILY UNLOCKS OUTSIDE LEVER. INSIDE LEVER ALWAYS FREE FOR EGRESS. OPERATING INSIDE LEVER SHUNTS DOOR POSITION SWITCH FOR REQUEST TO EXIT (REX).

HARDWARE GROUP NO. 46

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	224XY	628	IVE
2	EA	PUSH BAR	9100HD-A	630	IVE
2	EA	LONG DOOR PULL	9264F 24" A	630-316	IVE
1	EA	OH STOP	100S	630	GLY
1	EA	CONCEALED CLOSER	2034 BUMP SRI WMS	689	LCN
1	EA	SURF. AUTO OPERATOR	4642 WMS 120 VAC	689	LCN
2	EA	ACTUATOR, TOUCHLESS	8310-813		LCN
1	SET	WIRING DIAGRAMS	DOOR ELEVATION AND POINT-TO-POINT SEALS BY DOOR SUPPLIER		SCE

NOTE: INSTALL OVERHEAD STOP WITH AUTO DOOR OPERATOR.
OPERATIONAL DESCRIPTION: DOORS NORMALLY CLOSED AND UNLOCKED. PUSH/PULL OPERATION, EITHER MANUALLY, OR AUTOMATICALLY BY WALL-MOUNTED WAVE ACTUATOR (RHR LEAF).

HARDWARE GROUP NO. 47

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	224XY	628	IVE
2	EA	MANUAL FLUSH BOLT	FB458	626	IVE
1	EA	DUST PROOF STRIKE	DP1	626	IVE
1	EA	WIRELESS ACCESS CONTROL LOCK	BY OTHERS	630	SAL
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
2	EA	SURFACE CLOSER	4040XP SHCUSH SRI	689	LCN
1	EA	MEETING STILE	383AA	AA	ZER
2	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	625A-223	A	ZER
2	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

HARDWARE GROUP NO. 48

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	224XY	628	IVE
1	EA	CONST LATCHING BOLT	FB51P	630	IVE
1	EA	DUST PROOF STRIKE	DP1	626	IVE
1	EA	WIRELESS ACCESS CONTROL LOCK	BY OTHERS	630	SAL
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	COORDINATOR	COR X FL	US26D	IVE
2	EA	SURFACE CLOSER	4040XP SRI	689	LCN
2	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	MEETING STILE	383AA	AA	ZER
2	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

OPERATIONAL DESCRIPTION: DOORS NORMALLY CLOSED AND LOCKED. ACCESS BY KEY, OR VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCH AND MOMENTARILY UNLOCKS OUTSIDE LEVER. INSIDE LEVER ALWAYS FREE FOR EGRESS. OPERATING INSIDE LEVER SHUNTS DOOR POSITION SWITCHES FOR REQUEST TO EXIT (REX).

HARDWARE GROUP NO. 49

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	224XY	628	IVE
1	EA	CONST LATCHING BOLT	FB51P	630	IVE
1	EA	DUST PROOF STRIKE	DP1	626	IVE
1	EA	WIRELESS ACCESS CONTROL LOCK	BY OTHERS	630	SAL
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	COORDINATOR	COR X FL	US26D	IVE
2	EA	OH STOP	100S	630	GLY
2	EA	SURFACE CLOSER	4040XP SRI	689	LCN
1	EA	MEETING STILE	383AA	AA	ZER
2	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

OPERATIONAL DESCRIPTION: DOORS NORMALLY CLOSED AND LOCKED. ACCESS BY KEY, OR VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCH AND MOMENTARILY UNLOCKS OUTSIDE LEVER. INSIDE LEVER ALWAYS FREE FOR EGRESS. OPERATING INSIDE LEVER SHUNTS DOOR POSITION SWITCHES FOR REQUEST TO EXIT (REX).

HARDWARE GROUP NO. 50

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	224XY	628	IVE
1	EA	CONST LATCHING BOLT	FB51P	630	IVE
1	EA	DUST PROOF STRIKE	DP1	626	IVE
1	EA	WIRELESS ACCESS CONTROL LOCK	BY OTHERS	630	SAL
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	COORDINATOR	COR X FL	US26D	IVE
2	EA	SURFACE CLOSER	4040XP HCUSH SRI	689	LCN
1	EA	MEETING STILE	383AA	AA	ZER
2	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

OPERATIONAL DESCRIPTION: DOORS NORMALLY CLOSED AND LOCKED. ACCESS BY KEY, OR VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCH AND MOMENTARILY UNLOCKS OUTSIDE LEVER. INSIDE LEVER ALWAYS FREE FOR EGRESS. OPERATING INSIDE LEVER SHUNTS DOOR POSITION SWITCHES FOR REQUEST TO EXIT (REX).

HARDWARE GROUP NO. 51

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	224XY	628	IVE
1	EA	CONST LATCHING BOLT	FB51P	630	IVE
1	EA	DUST PROOF STRIKE	DP1	626	IVE
1	EA	WIRELESS ACCESS CONTROL LOCK	BY OTHERS	630	SAL
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	COORDINATOR	COR X FL	US26D	IVE
2	EA	SURFACE CLOSER	4040XP HCUSH SRI	689	LCN
1	EA	RAIN DRIP	142AA	AA	ZER
1	EA	MEETING STILE	383AA	AA	ZER
2	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	655A-223	A	ZER
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

OPERATIONAL DESCRIPTION: DOORS NORMALLY CLOSED AND LOCKED. ACCESS BY KEY, OR VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCH AND MOMENTARILY UNLOCKS OUTSIDE LEVER. INSIDE LEVER ALWAYS FREE FOR EGRESS. OPERATING INSIDE LEVER SHUNTS DOOR POSITION SWITCHES FOR REQUEST TO EXIT (REX).

HARDWARE GROUP NO. 52

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-78-NL-CON 24 VDC	630	VON
1	EA	RIM CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	SURFACE CLOSER	4040XP CUSH SRI	689	LCN
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	625A-223	A	ZER
1	EA	WIRE HARNESS	CON-6W		SCH
1	EA	WIRE HARNESS	CON-XX-P LENGTH AS REQUIRED FOR USE WITH DOOR		SCH
1	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	POWER SUPPLY	PS902 BBK 900-2RS KL900 120/240 VAC	LGR	SCE
1	SET	WIRING DIAGRAMS	DOOR ELEVATION AND POINT-TO-POINT		SCE
1	EA	NOTE	SEALS BY FRAME SUPPLIER. CARD READER BY OTHERS		

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. ACCESS BY KEY OR VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCH AND MOMENTARILY RETRACTS LATCHBOLT. INSIDE ALWAYS FREE FOR EGRESS. DEPRESSING INSIDE PUSH RAIL SHUNTS DOOR POSITION SWITCH FOR REQUEST TO EXIT (REX).

HARDWARE GROUP NO. 53

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	700CS TWP CON	441	IVE
1	EA	ELEC PANIC HARDWARE	LD-RX-LC-98-L-M996-03-FSE	630	VON
1	EA	RIM CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	SURFACE CLOSER	4040XP CUSH SRI	689	LCN
1	EA	WIRE HARNESS	CON-6W		SCH
1	EA	WIRE HARNESS	CON-XX-P LENGTH AS REQUIRED FOR USE WITH DOOR		SCH
1	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	POWER SUPPLY	PS902 BBK 900-2RS KL900 120/240 VAC	LGR	SCE
1	SET	WIRING DIAGRAMS	DOOR ELEVATION AND POINT-TO-POINT		SCE
			CARD READER BY OTHERS		
1			SEALS BY DOOR SUPPLIER		

NOTE: GASKET BY WATERTIGHT DOOR SUPPLIER.

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. ACCESS BY KEY OR VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCH AND MOMENTARILY UNLOCKS OUTSIDE LEVER. INSIDE ALWAYS FREE FOR EGRESS. DEPRESSING INSIDE PUSH RAIL SHUNTS DOOR POSITION SWITCH FOR REQUEST TO EXIT (REX).

HARDWARE GROUP NO. 54

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP	630	IVE
1	EA	PANIC HARDWARE	CD-78-L-03SS	630	VON
1	EA	RIM CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	SURFACE CLOSER	4040XP EDA SRI	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP/HOLDER	WS40	626	IVE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		

HARDWARE GROUP NO. 55

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	224XY EPT	628	IVE
1	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-78-NL-CON 24 VDC	626	VON
1	EA	RIM CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	SURFACE CLOSER	4040XP SHCUSH SRI	689	LCN
1	EA	WIRE HARNESS	CON-6W		SCH
1	EA	WIRE HARNESS	CON-XX-P LENGTH AS REQUIRED FOR USE WITH DOOR		SCH
1	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	POWER SUPPLY	PS902 BBK 900-2RS KL900 120/240 VAC	LGR	SCE
1	SET	WIRING DIAGRAMS	DOOR ELEVATION AND POINT-TO-POINT		SCE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		
1			CARD READER BY OTHERS		

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. AUTHORIZED ACCESS BY KEY OR VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCH AND RETRACTS LATCH BOLT, ALLOWING DOOR TO BE PULLED OPEN. IMMEDIATE EGRESS ALWAYS ALLOWED. DEPRESSING EXIT DEVICE PUSH RAIL SHUNTS DOOR POSITION SWITCH FOR REQUEST TO EXIT (REX).

HARDWARE GROUP NO. 56

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	224XY EPT	628	IVE
1	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	ELEC FIRE EXIT HARDWARE	RX-QEL-78-NL-F-CON 24 VDC	630	VON
1	EA	RIM CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	SURFACE CLOSER	4040XP SCUSH SRI	689	LCN
1	EA	RAIN DRIP	142AA	AA	ZER
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	625A-223	A	ZER
1	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	POWER SUPPLY	PS902 BBK 900-2RS KL900 120/240 VAC	LGR	SCE
1	SET	WIRING DIAGRAMS	DOOR ELEVATION AND POINT-TO-POINT		SCE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		
1			CARD READER BY OTHERS		

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. AUTHORIZED ACCESS BY KEY OR VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCH AND MOMENTARILY RETRACTS EXIT DEVICE LATCH BOLT, ALLOWING DOOR TO BE PULLED OPEN. IMMEDIATE EGRESS ALWAYS ALLOWED. DEPRESSING EXIT DEVICE PUSH RAIL SHUNTS DOOR POSITION SWITCH FOR REQUEST TO EXIT (REX).

HARDWARE GROUP NO. 57

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	224XY EPT	628	IVE
1	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-78-NL-CON 24 VDC	630	VON
1	EA	RIM CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	SURFACE CLOSER	4040XP SCUSH SRI	689	LCN
1	EA	RAIN DRIP	142AA	AA	ZER
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	625A-223	A	ZER
1	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	POWER SUPPLY	PS902 BBK 900-2RS KL900 120/240 VAC	LGR	SCE
1	SET	WIRING DIAGRAMS	DOOR ELEVATION AND POINT-TO-POINT		SCE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		
1			CARD READER BY OTHERS		

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. AUTHORIZED ACCESS BY KEY OR VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCH AND RETRACTS LATCH BOLT, ALLOWING DOOR TO BE PULLED OPEN. IMMEDIATE EGRESS ALWAYS ALLOWED. DEPRESSING EXIT DEVICE PUSH RAIL SHUNTS DOOR POSITION SWITCH FOR REQUEST TO EXIT (REX).

HARDWARE GROUP NO. 58

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	224XY EPT	628	IVE
2	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	REMOVABLE MULLION	KR4954 STAB	689	VON
1	EA	ELEC PANIC HARDWARE	LD-RX-78-EO-CON	630	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-78-NL 24 VDC	630	VON
1	EA	RIM CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	MORTISE CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
2	EA	SURFACE CLOSER	4040XP SHCUSH SRI	689	LCN
1	EA	RAIN DRIP	142AA	AA	ZER
1	EA	MULLION SEAL	8780NBK PSA	BK	ZER
2	EA	MEETING STILE	8879AA	AA	ZER
2	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	625A-223	A	ZER
1	EA	WIRE HARNESS	CON-6W		SCH
2	EA	WIRE HARNESS	CON-XX-P LENGTH AS REQUIRED FOR USE WITH DOOR		SCH
2	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	POWER SUPPLY	PS902 BBK 900-2RS KL900 120/240 VAC	LGR	SCE
1	SET	WIRING DIAGRAMS	DOOR ELEVATION AND POINT-TO-POINT		SCE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		
1			CARD READER BY OTHERS		

OPERATIONAL DESCRIPTION: DOORS NORMALLY CLOSED AND LOCKED. ACCESS BY KEY, OR VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCHES AND MOMENTARILY RETRACTS EXIT DEVICE LATCHBOLT. INSIDE ALWAYS FREE FOR EGRESS. OPERATING INSIDE PUSH RAILS SHUNTS DOOR POSITION SWITCHES FOR REQUEST TO EXIT (REX).

HARDWARE GROUP NO. 59

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	224XY EPT	628	IVE
2	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-7547-EO-CON 24 VDC	626	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-7547-NL-OP-388-CON 24 VDC	626	VON
1	EA	RIM CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
2	EA	LONG DOOR PULL	9264F 24" A	630-316	IVE
2	EA	CONCEALED CLOSER	2034 BUMP SRI WMS	689	LCN
2	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	545A	A	ZER
2	EA	WIRE HARNESS	CON-6W		SCH
1	EA	WIRE HARNESS	CON-XX-P LENGTH AS REQUIRED FOR USE WITH DOOR		SCH
2	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	POWER SUPPLY	PS902 BBK 900-2RS KL900 120/240 VAC	LGR	SCE
1	SET	WIRING DIAGRAMS	DOOR ELEVATION AND POINT-TO-POINT		SCE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		
1			CARD READER BY OTHERS		

OPERATIONAL DESCRIPTION: DOORS NORMALLY CLOSED AND LOCKED. ACCESS BY KEY, OR VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCHES AND MOMENTARILY RETRACTS EXIT DEVICE LATCHBOLTS. INSIDE ALWAYS FREE FOR EGRESS. OPERATING INSIDE PUSH RAIL SHUNTS DOOR POSITION SWITCHES FOR REQUEST TO EXIT (REX).

HARDWARE GROUP NO. 60

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	224XY EPT	628	IVE
2	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-7547-EO-CON 24 VDC	626	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-7547-NL-OP-388-CON 24 VDC	626	VON
1	EA	RIM CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
2	EA	LONG DOOR PULL	9264F 24" A	630-316	IVE
1	EA	OH STOP	100S	630	GLY
1	EA	CONCEALED CLOSER	2034 BUMP SRI WMS	689	LCN
1	EA	SURF. AUTO OPERATOR	4642 WMS 120 VAC	689	LCN
2	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	545A	A	ZER
2	EA	WIRE HARNESS	CON-6W		SCH
1	EA	WIRE HARNESS	CON-XX-P LENGTH AS REQUIRED FOR USE WITH DOOR		SCH
2	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	POWER SUPPLY	PS902 BBK 900-2RS KL900 120/240 VAC	LGR	SCE
1	SET	WIRING DIAGRAMS	DOOR ELEVATION AND POINT-TO-POINT		SCE
1	EA	NOTE	SEALS BY FRAME SUPPLIER.		
1			CARD READER BY OTHERS		

OPERATIONAL DESCRIPTION: DOORS NORMALLY CLOSED AND LOCKED. ACCESS BY KEY, OR VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCHES AND MOMENTARILY RETRACTS EXIT DEVICE LATCHBOLTS, ALLOWING RHR DOOR TO BE PULLED OPEN MANUALLY, OR AUTOMATICALLY BY OUTSIDE WAVE ACTUATOR. INSIDE ALWAYS FREE FOR EGRESS. OPERATING INSIDE PUSH RAIL SHUNTS DOOR POSITION SWITCHES FOR REQUEST TO EXIT (REX). INSIDE WAVE ACTUATOR RETRACTS EXIT DEVICE LATCHBOLT (RHR LEAF) AND AUTOMATICALLY OPENS DOOR.

HARDWARE GROUP NO. 61

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP	630	IVE
1	EA	FIRE EXIT HARDWARE	78-L-F-03	626	VON
1	EA	RIM CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	SURFACE CLOSER	4040XP CUSH SRI	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

HARDWARE GROUP NO. 62

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	WIRELESS ACCESS CONTROL LOCK	BY OTHERS	630	SAL
1		NOTE	BALANCE OF EXISTING HARDWARE TO REMAIN.		

HARDWARE GROUP NO. 63

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	700CS TWP CON	441	IVE
1	EA	ELEC FIRE EXIT HARDWARE	RX-LC-98-L-F-M996-03-FSE	630	VON
1	EA	RIM CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	SURFACE CLOSER	4040XP EDA SRI	689	LCN
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	WIRE HARNESS	CON-6W		SCH
1	EA	WIRE HARNESS	CON-XX-P LENGTH AS REQUIRED FOR USE WITH DOOR		SCH
1	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	POWER SUPPLY	PS902 BBK 900-2RS KL900 120/240 VAC	LGR	SCE
1	SET	WIRING DIAGRAMS	DOOR ELEVATION AND POINT-TO-POINT		SCE
			CARD READER BY OTHERS		
1			SEALS BY DOOR SUPPLIER		

NOTE: GASKET BY WATERTIGHT DOOR SUPPLIER.

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. ACCESS BY KEY OR VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCH AND MOMENTARILY UNLOCKS OUTSIDE LEVER. INSIDE ALWAYS FREE FOR EGRESS. DEPRESSING INSIDE PUSH RAIL SHUNTS DOOR POSITION SWITCH FOR REQUEST TO EXIT (REX).

HARDWARE GROUP NO. 64

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP	630	IVE
1	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	ELEC FIRE EXIT HARDWARE	RX-QEL-78-NL-F-CON 24 VDC	630	VON
1	EA	RIM CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	SURFACE CLOSER	4040XP CUSH SRI	689	LCN
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	WIRE HARNESS	CON-6W		SCH
1	EA	WIRE HARNESS	CON-XX-P LENGTH AS REQUIRED FOR USE WITH DOOR		SCH
1	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	POWER SUPPLY	PS902 BBK 900-2RS KL900 120/240 VAC	LGR	SCE
1	SET	WIRING DIAGRAMS	DOOR ELEVATION AND POINT-TO-POINT		SCE
			CARD READER BY OTHERS		

OPERATIONAL DESCRIPTION: DOOR NORMALLY CLOSED AND LOCKED. ACCESS BY KEY OR VALID CREDENTIAL, WHICH SHUNTS DOOR POSITION SWITCH AND MOMENTARILY RETRACTS LATCHBOLT. INSIDE ALWAYS FREE FOR EGRESS. DEPRESSING INSIDE PUSH RAIL SHUNTS DOOR POSITION SWITCH FOR REQUEST TO EXIT (REX).

HARDWARE GROUP NO. 65

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	700CS	441	IVE
1	EA	PANIC HARDWARE	LD-98-L-03	630	VON
1	EA	RIM CYLINDER	AS REQUIRED x 'L4' KWY	626	C-R
1	EA	SURFACE CLOSER	4040XP EDA SRI	689	LCN
1	EA	WALL STOP/HOLDER	WS40	626	IVE
1			SEALS BY DOOR SUPPLIER		

NOTE: GASKET BY WATERTIGHT DOOR SUPPLIER.

HARDWARE GROUP NO. 66

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	INVISIBLE HINGE	218SS	630	SOS
2	EA	TOUCH LATCH	20125LP	628	SLM

END OF SECTION

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SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:

1. Exterior storefront framing.
2. Curtainwall.
3. Glazed entrances.
4. Interior storefront framing.

B. Related Sections:

1. 081416, Flush Wood Doors.
2. 084113, Aluminum FRP Flush Doors and Frames.
3. 084113, Aluminum-Framed Entrances and Storefronts.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design glass, including comprehensive engineering analysis according to ASTM E 1300 by a qualified professional engineer, using the following design criteria:

1. Design Wind Pressures: Minimum are to be those associated with a 121 mph Basic Wind Speed, per requirements in Chapters 16 and 17 of the NC Building Code.
2. Vertical Glazing: For glass surfaces sloped 15 degrees or less from vertical, design glass to resist design wind pressure based on glass type factors for short-duration load.

1.3 ACTION SUBMITTALS

A. Product Data: For each glass product and glazing material indicated.

B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches (300 mm) square.

C. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

D. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 QUALITY ASSURANCE

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. GANA Publications: GANA's "Glazing Manual."
2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

B. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having

jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, test standard, whether glazing is for use in fire doors or other openings, whether or not glazing passes hose-stream test, whether or not glazing has a temperature rise rating of 450 deg F (250 deg C), and the fire-resistance rating in minutes.

D. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.

1.5 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form in which coated-glass manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

1. Warranty Period: 10 years from date of acceptance by Owner.

B. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form in which insulating-glass manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

1. Warranty Period: 10 years from date of acceptance by Owner.

PART 2 - PRODUCTS

2.1 GLASS PRODUCTS, GENERAL

A. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.

B. Strength: Provide annealed float glass, Kind FT heat-treated float glass in all locations.

C. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:

1. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K).
2. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
3. Visible Reflectance: Center-of-glazing values, according to NFRC 300.
4. Viracon Product, used below, is “Opti-White”.

D. Glass and Fabricated Glazing Products by the following manufacturers will be acceptable:

1. Viracon (Basis of Design)
2. Pilkington
3. Cardinal
4. Vitro

2.2 MATERIALS

A. Float Glass: ASTM C 1036, Type I, Quality-Q3, Class I, for interior single-pane applications.

B. Float Glass: ASTM C 1036, Type I, Quality-Q5, Class I (ultra-clear, low-iron) unless otherwise indicated.

C. Patterned Glass: ASTM C 1036, Type I, Quality-Q5, Form 3, Finish I (ultra-clear, low-iron) unless otherwise indicated.

D. Glazing Gaskets: Dense compression, grey.

E. All float glass is ¼-inch thickness, fully-tempered.

2.3 MONOLITHIC-GLASS TYPES

A. Glass Type GL-1: Clear, tempered, ¼-inch.

2.4 INSULATING-GLASS TYPES

A. Glass Type GL-2: Clear, fully tempered, low-e, insulating vision glass.

1. Outdoor Lite: GL-1, with VE85 on surface #2.
2. Indoor Lite: GL-1.

2.5 GLAZING GASKETS

A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from the following:

1. Neoprene complying with ASTM C 864. Color: Gray.

2.6 MISCELLANEOUS GLAZING MATERIALS

A. Cleaners: Types recommended by gasket manufacturer.

B. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

C. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

D. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walk).

PART 3 - EXECUTION

3.1 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

F. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm).

G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

3.2 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

C. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Install gaskets so they protrude past face of glazing stops.

3.3 CLEANING AND PROTECTION

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

END OF SECTION 088000

SECTION 088400 - EXHIBIT TANK GLAZING

PART 1 – GENERAL

1.1 DESCRIPTION

A. This Section includes the following:

1. Furnish and install acrylic glazing panels at tank including all items listed below and all other materials and services required to install and seal the glazing panels.

2. Supplementary sheet neoprene rubber, polyethylene foam back-up, acrylic setting blocks, filler strips. Protective blocks, and cap rings in amounts required for glazing conditions shown.

3. Fiberglass reinforced plastic (FRP) clips and bolts.

4. Factory chemical bonding of panels.

5. High-speed, non-shrink grout as required.

6. 1 or 2-part, silicone sealant. – Grey or Black as selected by the Architect/Designer.

7. Epoxy coating of window recesses

8. Testing of epoxy coating for compatibility with sealant system.

B. Related Sections include the following:

1. Exhibit Tank Coating is specified in Section 099800.

1.2 SYSTEM DESCRIPTION

A. Design Requirements:

1. Provide engineering design for panel thickness and installation anchorage system.

2. Safety factor for acrylic panel shall be based on the minimum allowable physical properties as defined by the latest revision of ASME PVHO-1 Standards and shall be not less than 11.25 for monolithic casting, and not less than 12.8 for bonded assemblies.

3. Fire Hazard Classification: Class III when tested in accordance with ASTM E84.

4. Panel identification numbers, visible horizontal and vertical vision dimensions and water depth are indicated on the Drawings.

5. Ambient design temperature of tanks varies by tank, refer to LSS drawings, plus or minus 3 degrees.

6. Design panels to comply with the 2018 NC State Building Code (2015 IBC) and all other applicable requirements regarding seismic design and incorporating slosh surge effect on water pressure, with initial maximum deflection of panels in long span direction of L/360 when tank is full as minimal design criteria.

Where panels are supported on 3 sides or cantilevered and the top edge is below 6'-0" above finished floor, design panels to not exceed L/600 in the long span direction.

a. Deflection over a long period of time shall not be visually perceptible and shall not be detrimental to reflection refraction and/or diffraction.

B. Performance Requirements: Provide watertight acrylic window panels when installed in manufacturer approved concrete openings meeting manufacturer's approved tolerances.

1.3 SUBMITTALS

A. Product Data: For each type of product specified.

B. Shop Drawings:

1. Submit shop drawings for fabrication and installation of acrylic panels and associated components, including elevations, bonded seam location and detail sections of all panels.

2. Identify full dimensions of all panels.

3. Clearly identify the location of all chemical bonds for all panels

C. Samples:

1. Joint Sealants: Submit for approval 12-inch-long samples of each color required for each type of sealant or caulking compounds.

2. Acrylic Panels: Submit 2 samples of plastic panel 12 inches by 12 inches of each panel thickness required. Samples to include butt or mitered joints where proposed.

D. Quality Control Submittals:

1. Design Data:

a. Furnish calculations signed by Structural engineer to satisfaction of local code jurisdictions to substantiate compliance with design requirements including seismic design.

b. Provide panel thickness definition within plus or minus 1/2 inch of final calculated thickness to the Designer not more than 14 calendar days after receipt of Notice to Proceed.

c. Provide calculation of initial and long-term deflection of all panels and identify point of maximum deflection in shop drawings

2. Test Reports:

a. Submit product test reports for each type of joint sealant indicated, evidencing compliance with requirements specified.

b. Joint Sealant Manufacturer: Submit statement indicating that acrylic and glazing materials have been tested for compatibility and adhesion with glazing sealants.

c. Include interpretation of test results relative to sealant performance and recommendations for primers and substrate preparation needed to

obtain adhesion.

d. Preconstruction Field Test Reports: Submit test reports indicating which products and joint preparation methods demonstrate acceptable adhesion to joint substrate.

3. Certificates:

a. Joint Sealant Manufacturer: Submit certification that sealants plus the primers and cleaners required for sealant installation comply with local regulations controlling use of volatile organic compounds. Also, submit certification attesting that products comply with specification requirements and are suitable for the use indicated. Sealants not certified by the manufacturer for use as aquarium glazing sealant shall not be accepted.

b. Acrylic Panel Manufacturer: Provide written certificates that panel thickness provided will withstand water pressures indicated and seismic loads. Submit documentation of compliance with ASME PVHO-1 requirements.

4. Manufacturer's Instructions: Submit acrylic panel manufacturer's installation and maintenance instructions.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain acrylic panels and joint setting and sealing materials through one source from a single manufacturer.

B. Qualifications:

1. Manufacturer and installer shall have successfully completed within the last 5 years at least 3 acrylic panel production and installations similar in type and size to that of this Project. Include list of completed projects with project names, addresses, name of architects and owners, plus other information specified.

2. Manufacturer shall provide technical supervisors to be present at time of panel unloading, installation and sealant application by manufacturer's personnel.

C. Preconstruction Field Testing:

1. Prior to installation of joint sealants, field test at jobsite their adhesion to joint substrates as follows:

a. Locate test joints where indicated or, if not indicated, as directed by the Architect.

b. Conduct field tests for each type of elastomeric sealant and joint substrate indicated.

c. Arrange for tests to take place with joint sealant manufacturer's technical representative present.

d. Test Method: Test joint sealants by hand pull method described below:
1) Install joint sealants in 5-foot joint lengths using same materials and methods for joint preparation and joint Sealant installation required for completed work. Allow sealants to cure

fully before testing.

2) Make knife cuts horizontally from one side of joint to the other followed by 2 vertical cuts approximately 2 inches long at side of joint and meeting horizontal cut at top of 2 inch cuts. Place a mark 1 inch from top of inch piece.

3) Use fingers to grasp 2-inch piece of sealant just above - inch mark; pull firmly down at a 90 degree angle or more while holding a ruler along the side of sealant. Pull sealant out of joint to the distance recommended by sealant

manufacturer for testing adhesive capability, but not less than that equaling specified maximum movement capability in extension; hold this position for 10 seconds.

4) Report whether or not sealant in joint connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate.

e. Evaluation of Field Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

D. Pre-Installation Conference: Contractor, installer, sealant, waterproofing and acrylic manufacturers' technical representatives, Architect and other trades whose work affects glazing shall meet at Project site to review procedures and time schedule proposed for glazing and coordination with other work,

1.5 DELIVERY, STORAGE AND HANDLING

A. Storage and Protection: Protect acrylic panel material during transport, delivery to job site, storage and handling to comply with manufacturer's directions and as required to prevent edge damage to acrylic panel and damage to acrylic material from effects of moisture, including condensation, temperature changes, direct exposure to sun and from other causes.

1.6 PROJECT CONDITIONS

A. Environmental Requirements: Provide climate control during installation of acrylic panels, to include temporary facilities if required.

B. Field Measurements: Take field measurements before fabrication. Verify openings are acceptable prior to application of waterproofing. Where necessary, proceed with fabrications without field measurements and coordinate fabrication tolerances to ensure proper fit of acrylic panel units. Show recorded measurement on final shop drawings.

C. Coordinate fabrications schedule with construction progress to avoid delay.

D. Delivery and installation on site will require coordination and confirmation with the construction managers and Owner’s project manager’s sufficient to assure that the delivery routes in and to the final locations for acrylic panels are free and clear of any obstructions that would otherwise prevent the installation to occur.

1.7 SEQUENCING AND SCHEDULING

A. Acrylic panels must be delivered to the site by specific dates in order for the project to remain on schedule. For this project, acrylic panels must be delivered to the site and into their general position no later than the CMR Project Schedule requires unless otherwise instructed. This schedule will be available upon request by the fabricator.

1.8 WARRANTY

A. Warranty period for this work is for a 1-year duration from time of acceptance (post hydrotest).

B. Written warranty, signed by the authorized representative of acrylic panel manufacturer and installer and countersigned by the Contractor, warranting that portions of the work involving tank glazing is of good quality, free from defects and conformance with the requirements of the Contract Documents and shall repair or replace defective work during the 1-year period following Acceptance of the Project by the Owner. Warranty shall include removal and replacement of other work that conceals acrylic or sealant and repair and/or replacement of other materials damaged by leakage

1. Defective work is defined to include the following:

a. Structural failure.
b. Noticeable yellowing or change of color.
c. Loss of impact or abrasion resistance.
d. Penetration of water through acrylic or sealant.
e. Adhesion or cohesive failure of sealant.
f. Crazing of acrylic surface or joints.
g. Excessive deflection
h. Failure to fulfill other specified performance requirements.
i. Appearance of void spaces, "bubbles", in bond joints and/or evidence of bond joint separation.

PART 2 – PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Provide Acrylic products by one of the following or by manufacturers with demonstrated experience of 10 years or greater and expertise with providing acrylic viewing windows for live animal exhibits:

1. Nippura Co. Ltd. 3611 Tryclan Dr..Charlotte, NC 28217 - USA
ph: 704.561.9191 FAX: 704.561.9196 http://www.nippura.com/en/index.html

2. Reynolds Polymer Technology, Inc. 607 Hollingsworth St. Grand Junction, CO 81505 – USA ph: 970.241.4700 Fax: 1970.241.4747
CustomerService@ReynoldsPolymer.com

3. Advanced Aquarium Technologies 610 Lockhaven Dr Houston, TX 77073 – USA ph:281.645.4004 https://www.advanced-aquariums.com/

2.2 MATERIALS

A. Acrylic Panel Glazing:

1. Monolithic cast or laminated from commercial grade polymethyl methacrylate resin, colorless and clear, with minimum haze and minimum 90 percent total light transmittance in accordance with ASTM D1003.

2. Casting process used in the production shall be capable of producing materials with the minimum physical properties shown in ASME PVHO-1 Standards with exception of the following:

   a. Acrylic panel glazing shall meet or exceed the following criteria:
      1) Flexural Strength (kgf/cm2):
         a) Parent Material: 1100.
         b) Joint Bond: 836.

      2) Flexural Rigidity (x 104 kfg/cm2) when tested in accordance with ASTM D79OM:
         a) Parent Material: 3.21.
         b) Joint Bond: 3.4.

      3) Tensile Strength (kgf/cm2) when tested in accordance with ASTM D638M:
         a) Parent Material: 823.
         b) Joint Bond: 646.

B. Sealant: 2 -component silicon as recommended by acrylic manufacturer and approved by sealant manufacturer. Primers as recommended by the sealant manufacturer.

C. Bond Breaker: As recommended by sealant manufacturer.

D. Spacers: Neoprene, ASTM C864, hardness as required by acrylic panel manufacturer.

E. Grout: Cementitious based, non-metallic, non-shrink, as recommended by acrylic panel manufacturer.

F. Painted Rebate Surfaces: Paint all rebate surfaces of acrylic – color to be determined.

G. Epoxy coating at window recesses:

1. Two component, 100% solids epoxy coating meeting:
   a. ANSI/NSF Standard 61 - drinking water components - health effects.
   b. EPA - potable water applications.
   c. FDA - 21 CFR 175.00 for food service contact
   d. USDA - direct food contact areas.

2. Primer: As recommended by coating manufacturer

3. Solvent: As recommended by coating manufacturer.

4. Patching Material: Epoxy patching compound as recommended by coating manufacturer

4. Color: gray or black, to match selected sealant color. Final color to be selected by Designer.

5. Manufacturers
   a. Madewell 1312S Epoxy Madewell Products Corporation, 7561A Industrial Court, Alpharetta, Georgia 30004. Phone (770) 475-8199. Fax (770) 475-8167. www.madewell.com.
   b. Sta-Crete SS1500"; Epmar Corporation, 13210 E. Barton Circle, Santa Fe Springs, CA 90670 (310) 946-8781.

2.3 ACCESSORIES

A. Provide accessory items including, but not limited to, the following as required by the acrylic panel manufacturer for a complete installation capable of meeting the performance requirements specified:

1. Neoprene bearing pads.
2. Installation clamps.
3. Backer rod.
4. Backer blocks.
5. Setting blocks.
6. Shims.
7. Paint for back coating of acrylic in recesses where required to prevent view through acrylic of inside of bearing area.
8. FRP clips and bolts (to be completely removed after sealant installation, unless otherwise noted in Drawings)
9. Surface primers as required for sealant adhesion.

2.4 FABRICATION

A. Laminate or monolithic cast plastic glazing unit monolithic, free from inclusions, which could decrease its structural performance or mar its optical characteristics or appearance.

B. Polished Surfaces: Provide surfaces with minimum of surface irregularities including waviness, ridges, dimples, and bumps.

C. Chamfer edges, except at field-bonded joints, per manufacturer to prevent chipping during shipping and installation.

D. Back-paint acrylic in bearing recesses where required to prevent view of inside of bearing areas from other windows. Acceptable exterior flat latex house paint manufacturers include:

1. Benjamin Moore
2. Sherwin Williams
3. Approved equivalent paint manufacturers to be reviewed and approved by

Owner and Exhibit Designer.

E. Chemical Bonds (seams):

1. Chemical bonds within the rebate areas and not exposed to view on the dry side may be used at the manufacturer's discretion.

2. Chemical bonds exposed to view on the dry side shall not occur in any panel less than 10'x20', regardless of panel orientation.

3. For this project, no horizontal chemical bonds will be allowed. All bonds to be in vertical orientation unless otherwise reviewed and authorized by the Owner's representatives and the Exhibit Designer.

4. On panels greater than 10'x20' and requiring chemical bonds:
   a. Exposed to view vertical bonds shall only be allowed where centered on the panel and/or equally spaced about the panel center
      i. Not less than 10' on center for panel greater than 10' high.
      ii. Not less than 20' on center for panels less than 10' high.

   b. Alternate chemical bond layout to minimize bonds within the prime viewing area to 10' above the floor of the viewer may be proposed for panels greater than 15' in both dimensions, subject to specific approval.

F. Inclusion Tolerances:

1. Each acrylic panel casting must be free of inclusions, which significantly decrease its structural performance or mar its optical appearance. The inclusion may take form of a void, a grain of sand, pebble, or any other form of foreign matter.
   a. Inclusions in excess of 0.25-inch combined dimensions are considered unacceptable.
   b. The number of allowable inclusions per panel is limited to 1 per 25 square feet in the general portion of the panel. Inclusions in the area from the bottom of the net panel opening to a height of 79 inches (eye level) are limited to 0.25-inch combined dimensions and number to 1 inclusion of this size maximum per 50 square feet.

2. Bonded joints of 2 structural components is acceptable for large flat sheets provided joint location is approved by the Owner, and the following criteria is met:

   a. Inclusions at area of bond:
      1) Maximum Size: 0.125-inch in combined dimensions.
      2) Quantity: Maximum of 1 per 6 feet of length.
      3) Inclusions in field chemical joints above the allowable limits will be reviewed and accepted at the sole discretion of the Owner's Representative.
   b. Bond joint physical properties shall meet the criteria specified above in "Acrylic Panel Glazing."

3. Flexural Strength: 7,000 psi ultimate strength, when tested in accordance with ASTM D790.

4. Residual Monomer: Less than 1.6 percent methyl methacrylate, less than 1.6

percent ethyl acrylate in accordance with ASME PVHO-1.

E. Fabrication Tolerances:

1. General: Tolerances to occur at design temperature and are based on fully assembled panel dimensions.

2. Thickness: Plus 0.50-inch, minus 0.00 inch from specified thickness, measured at any point.

3. Flatness: Plus or minus 0.25 by panel length in inches.

4. Deflection: Once installed and water is added to the exhibit, panel deflection cannot exceed 1/16" per linear foot (1/2" per 10 linear feet of panel length).

5. Width of Edge Chamfers: Typically, not to exceed 1/8 of panel thickness or 3/4-inch, whichever is less. At edges to be sealant joined, 1/8-inch maximum. No chamfers at edges to be field chemically bonded.

6. Width of Corner Chamfer: Not to exceed 0.0125 by panel thickness, not to exceed 3/4-inch.

7. Warp and twist shall not exceed 0.002 of the length when measured unrestrained on a flat surface, 3 corners relative to the fourth.

F. Optical Performances Prior to Shipment of Panels:

1. Equipment:
   a. Grid board consisting of 1 inch by 1 inch squares by 0.060-inch diameter white coated wire on flat black background; minimum height to be same height as the top of viewing area of panel (height minus rebate).
   b. Lighting of grid board consisting of 2 flood lamps of sufficient intensity to produce even, shadow-less illumination over board surface.

2. Procedure:
   a. Position grid board 24 to 48 inches from wet side of plastic glazing unit, with shortest edges in vertical position, parallel to glazing unit.
   b. Position lights on both sides of grid board between glazing unit and board, outside viewing areas, equidistant from center of grid board.
   c. Inspector will inspect glazing units from dry side, at distance of 24 to 36 inches from surface. Move grid board and lighting to allow inspection of entire panel surface.
   d. Inspection: Conducted by the Owner prior to shipment of panels to jobsite.

3. Acceptance Criteria: Surface is acceptable if image on grid board lines is clearly defined without distortion or breaks in lines exceeding 1/4 of grid square.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine openings to receive acrylic panel glazing and verify the following:

1. Perform bond and moisture tests on concrete substrates to determine that concrete is sufficiently cured and dry or if curing compounds are present.

2. Verify that crystalline capillary waterproofing has been installed and construction joints and shrinkage cracks in concrete that intersect window recesses have been epoxy injected.

3. That concrete surfaces are smooth, free from cracks, holes, protrusions, coatings or other unsatisfactory conditions that can impair performances.

4. That the area of overlap of epoxy with crystalline capillary waterproofing has been acid etched and neutralized in accordance with Section 09 98 00 – Exhibit Tank Coatings.

5. Size of concrete tanks and their openings are within tolerances specified.

B. Provide Glazier's written report listing conditions detrimental to performance of glazing work.

C. Do not allow glazing work to proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate, removing projections and substances detrimental to the work; comply with recommendations of manufacturers of products to be installed for proper preparation procedures.

B. Patch surface defects in areas to receive sealant, using epoxy patching compound per epoxy manufacturer's instructions.

C. Mix and apply a minimum of two coats of epoxy to window recesses for the extent shown on Drawings as per epoxy manufacturer's instructions. Coordinate application to not be visible from other windows. Ensure that application is flat, smooth, and free of cracks and pinholes and protect from wind-blown debris or water. Allow epoxy to cure for a minimum of 3 days prior to proceeding with installation of acrylic.

D. Construct suitable scaffolding both inside and outside each opening.

E. Comply with combined printed recommendations of acrylic manufacturers, of manufacturers of sealants, and other glazing materials, except where more stringent requirements are indicated.

F. Protect acrylic panels from edge damage during handling and installation. Remove from Project and dispose of acrylic units with edge damage or other imperfections of kind that, when installed, weakens acrylic and impairs performance and appearance.

3.3 INSTALLATION

A. General: Provide a complete and fully supervised panel installation, including provision of rigging and equipment required for unpacking, moving and setting panels. Comply with manufacturer's instructions, except where more stringent requirements are shown or specified, and except where Project conditions require extra precautions or provisions to ensure satisfactory performance of the work.

B. Apply surface primers to joint surfaces where required for adhesion of sealants, as

determined by preconstruction sealant substrate testing.

C. Apply neoprene bearing pads and set panels into openings in accordance with acrylic panel manufacturer's recommended procedure.

D. Provide edge blocking to comply with requirements of specifications, except where otherwise required by acrylic panel manufacturer.

E. Mix grout in accordance with packaged instructions and place into glazing channels as required for secure installation. Where acceptable to the acrylic manufacturer, provide continuous neoprene bearing pads in lieu of grout at openings smaller than 100 square feet.

1. Provide spaces, or similar means, at both ends of window to maintain space between concrete and panel edges free from grout in order to permit expansion.

2. Mask surfaces of panel and epoxy coated concrete above grouting level to prevent their soiling with grout.

3. Do not install dry side sealant until after window has been accepted as watertight. Provide other means to retain grout in recess and prevent contamination of window or areas to receive sealant.

3. Apply grout at sill and level evenly with lower edge of bevel as shown.

4. Grout jambs and head of window in stages as required to prevent boil-out of grout at lower elevations.

4. When surface moisture has disappeared, remove masking tapes.

F. Provide compressible filler rods or equivalent back-up material, as recommended by sealant and acrylic panel manufacturers, to prevent sealant from adhering to joint's back surface as well as to control depth of sealant for optimum performance, unless otherwise indicated.

G. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant substrate testing.

H. Mix and apply sealant at interior (wet) side of window. Comply with combined printed recommendations of manufacturers of glazing plastic and of sealants, and other glazing materials, except where more stringent requirements are indicated, including those of referenced glazing standards. Force sealant into glazing channels to eliminate voids and to ensure complete “wetting" or bond of sealant glazing plastic and channel surfaces. Tool exposed surfaces of sealants to provide a substantial "wash" away from glazing plastics.

I. Do not install dry side sealant until windows have been accepted as watertight.

J. All on-site assemblies of bonded joints (acrylic to acrylic) must be performed under dust-free, climate controlled temporary environments, and all such environments must be designed and approved by the Owner prior to their erection.

3.4 TOLERANCES

A. Install products of this Section to within the tolerances as stated above.

3.5 FIELD QUALITY CONTROL

A. Tests:

1. Fill tank to capacity with water after wet side sealant has cured (minimum 1-week duration or minimum recommended by sealant manufacturer) and after completion of all related work. Leak testing of acrylic may be concurrent with tests specified under 09 98 00 – Exhibit Tank Coating.

2. Verify initial deflection of acrylic meets specification requirements using dial indicator mounted to rigid test stand located on dry side at maximum deflection point of panel as indicated by shop drawings. Glazing Manufacturer shall responsible for correction of excessive deflection exceeding specifications.

3. Observe any leaks. If leakage is not evident, maintain tank full as per Item 4 below.

4. If leaks are present, empty tank and repair.
   a. Installer: Be responsible for repairing leaks at the perimeter of the glazing.
   b. Glazing Manufacturer: Be responsible for any problems with bonded joints deflection.

5. After apparent elimination of all leakage, but before installation of materials that might impede access to acrylic and sealant, fill tank and allow to stand full for a period of not less than 1 month to identify any slow leakage. Should leakage develop during this period, notify Architect prior to draining tank and receive approval for proposed repair methods.

6. Receive approval of Owner and Exhibit Designer before concluding water testing. Acceptance of installation shall be based upon 1-month continuous water testing without visible moisture present on the dry side of the acrylic or within window recesses. Dry side sealant shall be installed only after conclusion of water testing and approval of installation.

3.6 PROTECTION

A. Protect panels against damage from other construction, weather, direct exposure to sun, corrosion and other hazards as required to ensure that work of this Section will be without damage or deterioration at date of Substantial Completion. Minimum acceptable protection shall be plastic film approved by the acrylic manufacturer, followed by application of inner layer of 2” thick rigid insulation board and an outer layer of 1/8" plywood door skin or cellular plastic sheet.

END OF SECTION 088400

SECTION 089000 - LOUVERS AND VENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fixed, extruded-aluminum louvers.

B. Related Sections:

1. Refer to Drawings A – X Series for louver locations and dimensions.
2. Refer to Drawings M-X – X for louver requirements.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design louvers, including comprehensive engineering analysis by a qualified professional engineer, using structural performance requirements and design criteria indicated.

B. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors.

1. Wind Loads: Determine loads based on pressures associated with a Basic Wind Speed per requirements in Chapter 16 of the NC Building Code for Kure Beach, NC.

C. Seismic Performance: Louvers, including attachments to other construction, shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. Design earthquake loads based on pressures as indicated on Drawings.

D. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.

C. Samples: For each type of metal finish required.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T5, T-52, or T6.

B. Aluminum Sheet: ASTM B 209 (ASTM B 209M), Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.

C. Fasteners: Use types and sizes to suit unit installation conditions.

1. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.

D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.2 FABRICATION, GENERAL

A. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

B. Join frame members to each other and to fixed louver blades with fillet welds, concealed from view, unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.3 FIXED, EXTRUDED-ALUMINUM LOUVERS

A. Horizontal Storm-Resistant Louver:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. All-Lite Architectural Products, Inc, ECD 445 is Basis of Design Product.
b. Air Balance Inc.; a Mestek company.
c. Air Flow Company, Inc.
d. Airolite Company, LLC (The).
e. Construction Specialties, Inc.
f. Ruskin Company; Tomkins PLC.

B. Construction:

Material: Mill Finish 6063-T5 extruded aluminum.
Frame: 4” deep x 0.081” thick (102 x 2) channel.
Blades: 45° x 0.063” (1.7) thick horizontal drainable chevron style.
Screen: ½” x 0.063” (12.7 x 1.6) expanded and flattened aluminum.
18-by-16 (1.4-by-1.6mm) mesh aluminum insect screen.
Mullion: Visible.

C. Performance Data:

1. Based on testing 48 inch x 48 inch (1219mm x 1219mm) size unit in accordance with AMCA 500.
2. Free Area: 42.7% nominal
3. Free Area Size: 6.8 ft² (0.63 m²)
4. Maximum Recommended Air Flow thru Free Area: 1,250 fpm (6.35m/s).
5. Air Flow: 8,538 cfm (4.03m³/s).
6. Maximum Pressure Drop: 0.32in.wg. (79 Pa).
7. Water Penetration: Maximum of 0.01 ounces per square foot (3.1 g/m²) of free area at an air flow of 1,250 fpm (6.35m/s) free area velocity when tested for 15 minutes.
8. Minimum Wind Driven Rain performance @ 3 in/hr (75 mm/hr) rainfall rate and 29 mph (13 m/s) wind speed based on testing 39.375 inch x 39.375 inch (1 m x1 m) core area louver:

    a. Core Velocity: 397 fpm (2.15m/s)
    b. Effectiveness Ratio: 99%
    c. Wind Class: A
    d. Discharge Class: 3

9. AMCA Seal: Product must be licensed to bear the AMCA Certified Ratings Seal for Water, Air, and Wind Performance.

D. Design Load:

1. Wind Load: Louver designs shall withstand the effects of 30 psf (1.78 kPa) of uniform pressure acting inward or outward.
2. Seismic Performance: Louvers, including attachments to other construction, shall withstand seismic effects determined by ASCE-7.

E. Finish : Match clear anodized aluminum storefront.

2.4 ACCESSORIES

A. Blank-Off Panels

1. Insulated, aluminum skin with 2-Inch (51mm) insulated core, closure frame with perimeter gasket, black finish, and factory installed.

B. Extended sills, aluminum, 0.050-inch (1.27mm) nominal thickness, finished to match louver.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

D. Repair damaged finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory and refinish entire unit or provide new units.

E. Protect galvanized and nonferrous-metal surfaces that will be in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint.

END OF SECTION 089000

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing systems for interior gypsum board assemblies.
2. Suspension systems for interior gypsum ceilings and soffits.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: Provide materials and construction identical to those tested according to ASTM E 119.

B. STC-Rated Assemblies: Provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413.

2.2 FRAMING SYSTEMS

A. Steel Studs and Runners: ASTM C 645.

1. Minimum Base-Metal Thickness: 0.018 inch (0.45 mm) for stud lengths less than 9 feet. 0.027 inch (0.68 mm) for stud lengths over 9 feet.
2. Depth: As indicated on Drawings.

B. Slip-Type Head Joints: Where indicated, provide the following in thickness not less than indicated for studs and in width to accommodate depth of studs:

1. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes due to deflection of structure above.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following]:

1) Dietrich Metal Framing; SLP-TRK Slotted Deflection Track.
2) MBA Building Supplies; Slotted Deflecto Track.
3) Superior Metal Trim; Superior Flex Track System (SFT).
4) Telling Industries; Vertical Slip Track.

C. Cold-Rolled Channel Bridging: Steel, 0.053-inch (1.34-mm) minimum base-metal thickness, with minimum 1/2-inch- (13-mm-) wide flanges.

1. Depth: As required for assembly.
2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38 by 38 mm), 0.068-inch- (1.72-mm-) thick, galvanized steel.

D. Cold-Rolled Furring Channels: 0.053-inch (1.34-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges.

1. Depth: As required for assembly.
2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum uncoated-steel thickness of 0.033 inch (0.8 mm).
3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.

E. All items shall be G90 hot-dip galvanized, in accordance with ASTM C645 and A653.

2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.

B. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch (4.12 mm) in diameter.

C. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053 inch (1.34 mm) and minimum 1/2-inch- (13-mm-) wide flanges.

1. Depth: As required for assembly.

2.4 AUXILIARY MATERIALS

A. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at floor slabs: Provide 30# Class A asphalt saturated organic felt at all runners on slabs.

C. Provide 18 Gauge galvanized steel flat strapping, 8 to 10-inches wide, in lieu of wood blocking to support millwork, toilet partitions, toilet accessories, et cetera, in metal stud walls.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754.

1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

C. Install bracing at terminations in assemblies.

D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.2 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
    a. Install two studs at each jamb unless otherwise indicated.
    b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
    c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.

E. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

3.3 INSTALLING SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.

    a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
3. Do not attach hangers to steel roof deck.
4. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
5. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
6. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.

F. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 092216

SECTION 092713 - CASTWORKS GLASS FIBER REINFORCED GYPSUM (GRG/GFRG) ARCHITECTURAL COLUMNS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

This specification is a general outline the CastWorks Glass Fiber Reinforced Gypsum (GRG/GFRG) requirements, as they pertain to the overall project design. In all cases, the Manufacturer's printed specifications shall govern the work of this section.

1.2 SUMMARY

A. Section Includes:

1. Furnish all materials, labor, equipment, and services necessary for the supply and installation of CastWorks GRG components as indicated on the drawings and contract documents, all in compliance with local codes and/or ordinances.
2. Work shall include supply of GRG components, installation, and finishing guidance.

B. Related Sections:

1. Section 051200 Structural Metal Framing
2. Section 054000 Cold-Formed Metal Framing
3. Section 061053 Miscellaneous Rough Carpentry
4. Section 092900 Gypsum Board
5. Section 099123 Painting and Coating

1.3 References

A. American Society for Testing and Materials (ASTM):

1. ASTM C1355/C1355M Standard Specification for Glass Fiber Reinforced Gypsum Composites
2. ASTM C1381 Standard Specification for Molded Glass Fiber Reinforced Gypsum Parts
3. ASTM D638 Standard Test Method for Tensile Properties of Plastics
4. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials
5. ASTM C947 Standard Test Method for Flexural Properties of Thin-Section Glass-Fiber-Reinforced Concrete (Using Simple Beam with Third-Point Loading)
6. ASTM D256 Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
7. ASTM D696 Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between −30°C and 30°C with a Vitreous Silica Dilatometer
8. ASTM E136 Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C
9. ASTM C472 Standard Test Methods for Physical Testing of Gypsum, Gypsum Plasters and Gypsum Concrete

10. ASTM C473 Standard Test Methods for Physical Testing of Gypsum Panel Products
11. ASTM D2583 Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
12. ASTM C840 Standard Specification for Application and Finishing of Gypsum Board

1.4 SUBMITTALS

A. Submit a minimum of three 3" x 3" or 8" x 8" CastWorks GRG flat samples to the Finishing Contractor for paint selection.

B. Submit shop drawings for approval showing plans, sections, details, joint treatment, reinforcing, fastening devices and the relation of the CastWorks GRG components to the surrounding construction.

C. Product Data: Submit manufacturer's technical data.

1.5 RESPONSIBILITY

A. The Gypsum Board Contractor shall install and tape the work under this section and he will be responsible for coordinating the installation with drywall work and other trades.

1.6 MOCK-UP

A. Prior to production, erect one proto-type component on-site or at the Armstrong CastWorks plant, for review by the Architect.

1.7 DELIVERY, STORAGE, HANDLING AND PROTECTION

A. Transport and handle units in a manner that avoids excessive stresses or damage.

B. Components displaying obvious damage must be rejected at site at time of delivery.

C. Store the components in a controlled environment, weather protected, on level surfaces, with temporary supports as required. Do not stack or lean.

1.8 Warranty

A. One year from Acceptance by Owner.

PART 2. – PRODUCTS

2.1 MANUFACTURER

A. CastWorks by Armstrong World Industries, Inc. (Basis-of-Design product)

B. Subject to compliance with these Specifications, equivalent products by Formglas, GC Products and other manufacturers will be acceptable.

2.2 MATERIALS (Basis-of-Design product terminology used below, for consistency.)

A. CastWorks GRG components shall be prefabricated with high-density gypsum, free of resin and asbestos, reinforced with chopped strand fiber or continuous filament mat.

B. CastWorks GRG components shall be reinforced with steel or wood as needed.

C. Fabrication will be as per approved shop drawings and will not include assembly. If multiple components are required to complete design criteria as per contract drawings, additional site work under related section, installation or finishing may be required.

D. Furnish Columns in two halves, to be fitted around existing 16-inch square posts.

E. CastWorks GRG components shall be ready to receive primer and paint as specified under Section 099123.

2.3 TOLERANCES (FABRICATION)

A. Dimensional - all directions +/- 1/8"
B. Thickness - skin +/- 1/16"
C. Warpage or Bowing +/- 1/16"/foot
D. Site conditions and normal manufacturing variations may require additional site work to maintain these tolerances.

2.4 PHYSICAL PROPERTIES

A. Shell Thickness 3/16"
B. Weight (depending on reinforcing) 2 - 3 lbs/sq.ft
C. Density 103 - 112 lbs/cu.ft
D. Flexural Strength (ASTM C-947) Not less than 2500 psi.
E. Modulus of Elasticity - In flexure (ASTM C-947-89 MOD.) 3.38 x 10^6 psi.
F. Tensile Strength (ASTM D-638-94 b MOD.) 1,810 psi.
G. Impact Strength (ASTM D-256 notched) 3.26 ft.lb/ in. of notch
H. Impact Strength (ASTM D-256 unnotched) 8.0 ft.lb/ in^2.
I. Hardness – Barcol (ASTM D-2583-93) <50
J. Fiber Content 4 - 6% by weight
K. Humidified Deflection (ASTM C-473-95) 1/32" to 1/8" deflection
L. Coefficient of Expansion (ASTM D-696-91) 0.98 x 10^{-5} in./in./ ˚F
M. Fuel Contribution (ASTM E-136-98a) Pass
N. Flame Spread (ASTM E-84-94) 0, Class A
O. Smoke Index (ASTM E-84-94) 0, Class A
P. Fastener Withdrawal – Not less than 110 lbs

2.5 INSPECTION

A. The Architect or representative shall have access to the manufacturing facilities, either prior to contract award or thereafter, to inspect or verify compliance with the above specifications.

PART 3 - EXECUTION

3.1 PRE-INSTALLATION RESPONSIBILITY

A. Field Measurements: Prior to manufacturing, the Installer will be responsible for obtaining all field dimensions for inclusion on the Manufacturer’s shop drawings.

B. Coordination: The Installer will be responsible for the coordination of the installation with related sections, within the tolerances specified in the respective articles.

C. Discrepancies: Prior to installation, the Installer shall check job site dimensions and conditions. Any discrepancies between design and field dimensions shall be brought to the attention of the General Contractor and the Architect.

3.2 INSTALLATION

A. Components shall be lifted/handled with suitable devices.

B. Components shall be installed plum and true. Shim where necessary.

C. Fasten components with self-drilling, self-tapping bugle head screws through face or back as indicated on shop drawings.

D. Where components are suspended, use as a minimum 12-gauge galvanized steel wire and the suspension points indicated on the shop drawings.

E. Framing, hangers, etc. as specified for Gypsum Board.

F. Butt joints are to be adhered together using high grade polyurethane construction adhesive.

3.3 FINISHING

A. Refer to Painting Section of the Specifications.

B. The Paint Contractor shall comply with ASTM C 840-79 Specifications.

C. For joint finishing, tape, fill and sand all joints as required under Section 092900 of the Specifications and as outlined in U.S.G. or C.G.C. Gypsum Construction Handbook. Patch countersunk fasteners and any damage to match component texture.

3.4 NOTES

A. CastWorks GRG components shall be used for Interior Applications only.

B. Unfinished GRG may exhibit slight imperfections, normally hidden by textured or matte finishes. To obtain satisfactory results with joints and high sheens, additional filling, sanding, level 5 priming and painting may be required.

C. Improper sealing can cause tape joint read-through after painting. This is due to the difference in porosity between joint compounds and GRG therefore, ensure that the Painting Contractor seals all surfaces properly prior to finishing.

D. GRG components subject to critical lighting may require a level 5 finish by others.

END SECTION 092713

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Paperless (glass mat) gypsum board.
2. Paperless (glass mat) gypsum board for exterior soffits.
3. Paperless (glass mat) gypsum sheathing.
4. Water-resistant Gypsum Board for Interior Curved Walls.

B. Related Sections:

042000, Unit Masonry.
061053, Miscellaneous Rough Carpentry.
061600, Wall Sheathing at EIFS.
064023, Interior Architectural Woodwork.
079200, Joint Sealants.
081213, Hollow Metal Frames.
084113, Aluminum-Framed Entrances and Storefronts.
095113, Acoustical Panel Ceilings.
099123, Interior Painting.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples:

1. Paperless Gypsum Board: Manufacturer's standard size for each type indicated.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

C. Low Emitting Materials: For ceiling and wall assemblies, provide materials and construction identical to those tested in assembly and complying with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.2 INTERIOR GYPSUM BOARD

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. CertainTeed Corp.
2. Georgia-Pacific Gypsum LLC.
3. National Gypsum Company.
4. USG Corporation.

B. Glass-Mat Interior Gypsum Board for walls and ceilings: ASTM C 1658/C 1658M. With fiberglass mat laminated to both sides. Specifically designed for interior use.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Georgia-Pacific Gypsum LLC; DensArmour Plus (Basis-of-Design).
b. USG Sheetrock® Brand Glass-Mat Panels; Mold Tough.
c. Gold Bond® brand; eXP® Interior Extreme® Gypsum Panels
d. CertainTeed; GlasRoc.

2. Long Edges: Tapered.
3. Thickness: 5/8 inch (15.9 mm).
4. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

C. Fire-Rated Glass-Mat Interior Gypsum Wall Board, Type X: ASTM C 1658/C 1658M.

1. Thickness: 5/8 inch (15.9 mm).
2. Long Edges: Tapered.

D. Glass-Mat Gypsum Sheathing Board: ASTM C 1177/C 1177M, with fiberglass mat laminated to both sides and with manufacturer's standard edges. Use for tile backer board, exterior soffits and backer to EIFS.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; GlasRoc Sheathing.
b. Georgia-Pacific Gypsum LLC; Dens-Glass Gold.
c. National Gypsum Company; Gold Bond, e(2)XP.
d. USG Corporation; Securock Glass Mat Sheathing.

2. Core: As is standard for the product; ½" thickness.

E. Bendable Core, Mold, Mildew Moisture Resistant Gypsum Board: ASTM C1396/C1396M.

1. Products: Subject to compliance with requirements, products meeting this specification include the following:

a. CertainTeed Corp..
b. Georgia-Pacific Gypsum LLC.
c. National Gypsum Company; Gold Bond.
d. USG Corporation.

2. Core: As is standard for the product; 5/16" thickness, capable of bending to a 5-foot radius.

2.3 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Paper-faced galvanized steel sheet; L and J beads for mudding-in the flanges.

B. Exterior Trim: ASTM C 1047.

1. Material: Plastic. Provide bendable material at downspout location.

2.4 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:

1. For Glass-Mat Gypsum Wall Board and Sheathing Board: 10-by-10 glass mesh.

C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

2.5 AUXILIARY MATERIALS

A. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

1. Laminating adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Laminating adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Steel Drill Screws: ASTM C 1002, unless otherwise indicated. Screws for wet and exterior locations shall be stainless steel.

C. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing).

D. Acoustical Joint Sealant: ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings as demonstrated by testing according to ASTM E 90.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Accumetric LLC; BOSS 824 Acoustical Sound Sealant.
b. Grabber Construction Products; Acoustical Sealant GSC.
c. Pecora Corporation; AC-20 FTR.
d. Specified Technologies, Inc.; Smoke N Sound Acoustical Sealant.
e. USG Corporation; SHEETROCK Acoustical Sealant.

2. Acoustical joint sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Acoustical joint sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."

PART 3 - EXECUTION

3.1 APPLYING AND FINISHING PANELS

A. Comply with ASTM C 840.

B. All gypsum wall panels shall be glass mat, level 5 finish.

C. All exterior soffits will be paperless (glass mat) sheathing with EIFS finish.

D. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

E. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations and **apply edge trim where edges of panels are exposed**. Seal joints between edges and abutting piping, Tectum, and structural surfaces with acoustical sealant.

F. Install trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

1. Control Joints: Install control joints at locations indicated on Drawings and according to ASTM C 840 and in specific locations approved by Architect for visual effect.

G. Prefill open joints, rounded or beveled edges, and damaged surface areas.

H. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

I. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:

1. Level 1: Ceiling plenum areas, concealed areas including side of Mechanical Mezzanine walls that face above-ceiling areas.
2. Level 4: At interior soffits and ceilings.
3. Level 5: At wall panel surfaces that will be exposed to view unless otherwise indicated.

a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."

J. Protect adjacent surfaces from drywall compound and texture finishes and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

K. Remove and replace panels that are wet, moisture damaged, and mold damaged.

END OF SECTION 092900

SECTION 093000 – TILING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ceramic wall tile, and base tile.

B. Related Sections:

042000 Unit Masonry for wall substrate.
079200, Sealants
092900 Gypsum Board for wall substrate.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples:

1. Each type and composition of tile and for each color and finish required.
2. Assembled samples, with grouted joints, for each type and composition of tile and for each color and finish required.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering and identified with labels describing contents.

1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.

PART 2 - PRODUCTS

2.1 TILE PRODUCTS

A. ANSI Ceramic Tile Standard: Provide Standard grade tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated. Refer to Color Schedule 090000 for specific colors.

B. Porcelain interior floor tile.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. American Olean; Division of Dal-Tile International Inc.
b. Daltile; Division of Dal-Tile International Inc. (Keystones, Basis of Design Product)
c. Florida Tile Industries, Inc.

2. Module Size: 12 by 24 inches.
3. Thickness: 3/8 inches.
4. Face: Square edges.
5. Finish: Unglazed, matt.
6. Tile Color: Refer to Section 090000 Color Schedule.
7. Grout Color: Grey.

C. Porcelain interior base tile.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. American Olean; Division of Dal-Tile International Inc.
b. Daltile; Division of Dal-Tile International Inc. (Keystones, Basis of Design Product)
c. Florida Tile Industries, Inc.

2. Module Size: 2 by 2 inches.
3. Thickness: 5/16 inch (8 mm).
4. Face: Plain with modified cushion edges.
5. Finish: Unglazed, matt.
6. Tile Color: Refer to Section 090000 Color Schedule.
7. Grout Color: Grey.
8. Mounting: Factory, back mounted.
9. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:

a. Base: Daltile #MB-5B built up cove, 5 inches high.
b. External Corners for Thin-Set Mortar Installations: Surface bullnose, same size as adjoining flat tile.

D. Porcelain wall tile.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. American Olean; Division of Dal-Tile International Inc.
b. Daltile; Division of Dal-Tile International Inc. (Keystones, Basis of Design Product)
c. Florida Tile Industries, Inc.

2. Module Size: 2 by 2 inches.
3. Thickness: 5/16 inch (8 mm).
4. Face: Plain with modified cushion edges.
5. Finish: Unglazed, matt.
6. Tile Color: Refer to Section 090000 Color Schedule.
7. Grout Color: Grey.
8. Mounting: Factory, back mounted.

9. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:

    a. External Corners for Thin-Set Mortar Installations: Surface bullnose, same size as adjoining flat tile.

10. Description: Uniform, fine- to medium-grained white stone with gray veining.

2.2 SETTING MATERIALS

A. Latex-Portland Cement Mortar (Thin Set): ANSI A118.4.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Boiardi Products; a QEP company.
    b. Bonsal American; an Oldcastle company.
    c. Bostik, Inc.
    d. C-Cure.
    e. Custom Building Products.
    f. Laticrete International, Inc.
    g. MAPEI Corporation.
    h. Southern Grouts & Mortars, Inc.
    i. Summitville Tiles, Inc.
    j. TEC; a subsidiary of H. B. Fuller Company.

2. Prepackaged, dry-mortar mix to which only water must be added.
3. Prepackaged, dry-mortar mix combined with liquid-latex additive.
4. For wall applications, provide non-sagging mortar.

B. Tile over tile floors (ANSI A108.9).

1. Modified Epoxy Emulsion Mortar.

2.3 GROUT MATERIALS

A. Epoxy or Furan Tile Grout: ANSI A118.3, ANSI A118.5, or ISI RG.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Boiardi Products; a QEP company.
    b. Bonsal American; an Oldcastle company.
    c. Bostik, Inc.
    d. C-Cure.
    e. Custom Building Products.
    f. Laticrete International, Inc.
    g. MAPEI Corporation.
    h. Southern Grouts & Mortars, Inc.
    i. Summitville Tiles, Inc.
    j. TEC; a subsidiary of H. B. Fuller Company.

2.4 FLUID-APPLIED WATERPROOFING MEMBRANE

A. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Boiardi Products; a QEP company; Elastiment 644 Membrane Waterproofing System.
b. Bonsal American; an Oldcastle company; B 6000 Waterproof Membrane.
c. C-Cure; Pro-Red Waterproofing Membrane 63.
d. Custom Building Products; Redgard Waterproofing and Crack Prevention Membrane.
e. Laticrete International, Inc.; Laticrete Watertight Floor N' Wall Waterproofing.
f. MAPEI Corporation; Mapelastic HPG.

2.5 ELASTOMERIC SEALANTS

A. One-Part, Mildew-Resistant Silicone Sealant as Specified in Division 7 Section Joint Sealants.

2.6 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds:

1. Where ceramic tile flooring is to be replaced with epoxy coating, use Ardex V 1000 or equivalent product meeting the following performance requirements:
Flow Time: 10 minutes
Compressive Strength (ASTM C109/mod – Air cure only): 4,400 psi (308 kg/sq. cm.) at 28 days.
Flexural Strength (ASTM C348): 1,000 psi (70 kg/sq. cm.) at 28 days
VOC: 0

2. For all other conditions, use latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.

1. Verify that substrates for setting tile are firm, dry, clean, free of coatings that are incompatible with tile-setting materials including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.

3.2 PREPARATION

A. Clean all areas where tile has been removed and make ready to accept setting material for replacement tile.

B. Fill cracks, holes, and depressions in concrete substrates for tile floors and wall installed with thin-set mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.

3.3 INSTALLATION

A. Comply with TCNA's "Handbook for Ceramic Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 Series "Specifications for Installation of Ceramic Tile" that are referenced in TCA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.

B. Tile Installation Schedule:

1. Interior Floor Tile over existing ceramic tile floors (TR712). Use narrow (1/16-inch) joints.

2. Interior Wall Base Tile Installation (same as interior floor tile below): Thin-set mortar on masonry.

3. Interior Wall Tile Installation W245 (on glass-mat gypsum backer board); W2021 (thinset mortar over CMU).

    a. Floor Tile.
    b. Thin-Set Mortar: Portland cement mortar.
    c. Grout: Epoxy or Furan grout.

C. Extend tile work into recesses and behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

D. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

E. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.

F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.

G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:

1. 1/16 inch (1.6 mm).

I. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.

1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

J. Install backer units and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated. Use latex-portland cement mortar for bonding material unless otherwise directed in manufacturer's written instructions.

K. Install waterproofing to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness and bonded securely to substrate.

K. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness and bonded securely to substrate.

END OF SECTION 093000

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes acoustical panels and exposed suspension systems for ceilings.

1.2 ACTION SUBMITTALS (Only required if submitted item is different from Basis of Design).

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

B. Additional materials: Provide ten boxes of ceiling panels and sixty linear feet of track in equal amounts of two foot and four-foot length.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Acoustical ceiling shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
2. Smoke-Developed Index: 50 or less.

2.2 ACOUSTICAL PANEL CEILINGS, GENERAL

A. Low-Emitting Materials: Acoustical panel ceilings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Acoustical Panel Standard: Comply with ASTM E 1264.

C. Metal Suspension System Standard: Comply with ASTM C 635.

D. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

2.3 ACOUSTICAL PANELS – TYPE 1

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Armstrong World Industries, Inc. Kitchen Zone 673.
2. CertainTeed Corp.
3. Chicago Metallic Corporation.
4. USG Interiors, Inc.; Subsidiary of USG Corporation.

B. Classification: Type XII, Form 2, Pattern E, Fire Class A.

C. Color: White.

D. LR: 0.88.

E. SAG Resistance: HumiGuard Plus with BioBlock (proprietary for Armstrong) or equivalent.

F. Edge/Joint Detail: Square.

G. Thickness: 3/4 inch.

H. Modular Size: 24 by 24 inches (610 by 610 mm).

2.4 METAL SUSPENSION SYSTEM

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Armstrong World Industries, Inc.
2. CertainTeed Corp.
3. Chicago Metallic Corporation.
4. USG Interiors, Inc.; Subsidiary of USG Corporation.

B. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; pre-painted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 (Z90) coating designation; with prefinished 15/16-inch- (24-mm-) wide metal caps on flanges.

1. Structural Classification: Heavy-duty system.
2. End Condition of Cross Runners: Butt-edge type.
3. Face Design: Flat, flush.
4. Cap Material: Steel or aluminum cold-rolled sheet.
5. Cap Finish: Painted white.
6. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

B. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

1. Install track as shown on the Reflected Ceiling Plans.
2. Arrange directionally patterned acoustical panels in short direction or as indicated on reflected ceiling plans.
3. Avoid trapping debris on top of panels.

C. Protect track and panels from damage by trades. Replace damaged units prior to Substantial Completion.

END OF SECTION 095113

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SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Resilient base.
2. Resilient molding accessories.
3. Resilient treads and risers.

1.2 ACTION SUBMITTALS

A. Samples: For each type of product indicated, in manufacturer's standard-size Samples but not less than 12 inches (300 mm) long, of each resilient product color, texture, and pattern required.

1.3 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.

1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

1.4 PROJECT CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer in spaces to receive resilient products.

B. Until the date of Acceptance by Owner, maintain ambient temperatures within range recommended by manufacturer.

C. Install resilient products after other finishing operations, including painting, have been completed.

1.5 ADDITIONAL MATERIALS

A. Provide 50 linear feet of each specified product.

PART 2 - PRODUCTS

2.1 RESILIENT BASE

A. Resilient Base:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Armstrong World Industries, Inc.
    b. Burke Mercer Flooring Products; Division of Burke Industries, Inc.
    c. Flexco, Inc.
    d. Johnsonite (Slimline is Basis-of Design).
    e. Roppe Corporation, USA.

B. Resilient Base Standard: ASTM F 1861.

1. Material Requirement: Type TS (rubber, vulcanized thermoset).
2. Manufacturing Method: Group I (solid, homogeneous).
3. Style: Cove (base with toe).

C. Minimum Thickness: 0.125 inch (3.2 mm).

D. Height: 4 inches (102 mm).

E. Lengths: Cut lengths 48 inches (1219 mm) long or coils in manufacturer's standard length.

F. Outside Corners: Preformed, but Job formed will be acceptable when the length of material is more than 3 feet on both sides of the corner.

G. Inside Corners: Preformed.

H. Finish: Satin or Matte.

I. Colors and Patterns: Refer to Color Schedule 090000.

2.2 RESILIENT MOLDING ACCESSORY

A. Resilient Molding Accessory:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Armstrong World Industries, Inc
    b. Burke Mercer Flooring Products; Division of Burke Industries, Inc.
    c. Flexco, Inc.
    d. Johnsonite (Basis-of Design).
    e. Roppe Corporation, USA.

B. Description: Integral tread and riser for stairs. Reducer strip for resilient floor covering, transition strips between slab or other flooring and VC Tile.

C. Material: Rubber.

D. For tread texture, match Johnsonite “Cubis” for appearance and slip resistance.

E. Profile and Dimensions: Johnsonite “Slimline” CTA Series selected to match thickness of specified materials.

1. For color strips between floor jambs, provide 2-inch-wide strip that matches color and thickness of floor tile.

F. Colors and Patterns: Match the wall base color.

2.3 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, Portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.

1. Adhesives shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesives shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Concrete Substrates for Resilient Accessories: Prepare according to ASTM F 710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer.
4. Moisture Testing: Perform tests as required for the adjacent resilient flooring product.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install resilient products until they are same temperature as the space where they are to be installed.

1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

E. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

3.2 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

3.3 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.

B. Resilient Molding Accessories: Install transition strips to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of resilient floor covering that would otherwise be exposed.

C. The Architect will direct the location for each termination and transition. At door frames, the transition will be centered under the door. At masonry openings, the transition will occur such that the outer edge of the transition strip aligns with the edge of the Corridor.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protection of resilient products.

B. Cover resilient products until date of Acceptance by Owner.

END OF SECTION 096513

SECTION 096816 – TILE CARPETING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes direct glue-down loop carpet and integral backing; and includes stair nosings.

B. Related Sections:

033000, Cast-in-Place Concrete.
096253, Resilient Base and Accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show the following:

1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet.
2. Carpet type, color, and dye lot.
3. Seam locations, types, and methods.
4. Pile direction.

C. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

A. Warrant: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with CRI 104.

1.6 FIELD CONDITIONS

A. Comply with CRI 104 for temperature, humidity, and ventilation limitations.

1.7 WARRANTY

A. Special Warranty for Carpet: Manufacturer agrees to repair or replace components of carpet installation that fail in materials or workmanship within specified warranty period.

1. Warranty does not include deterioration or failure of carpet due to unusual traffic, failure of substrate, vandalism, or abuse.
2. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, loss of tuft bind strength and delamination.
3. Warranty Period: 5 years from date of Acceptance by Owner.

PART 2 - PRODUCTS

2.1 CARPET

Carpet 1A – Tile

Size: 24”x24”

Primary Backing: Non-woven synthetic fiber

Construction: Engaged Tufted Pattern Loop

Yarn System: 100% Recycled Content Nylon

Face Weight: 23 oz./sq. yd.

Machine Gauge: 1/10 inch.

Pile Height: 0.18

Stitches Per Inch: 7 stiches/inch

Pile Density: 6,273 oz/cy

Fiber: 100% Solution Dyed Nylon

Installation Method: Monolithic

Carpet Tile Unit Size: 19.69 inches x 9.69 inches.

Location: Per Finish Schedule.

Color and Pattern to be selected from Manufacturer’s full range.

Basis of Design: as manufactured by Interface, 1280 West Peachtree St NW, Atlanta, GA 30309 PRODUCT: NET EFFECT COLLECTION, STYLE B603. Subject to matching the above specifications other manufacturers will be considered.

2.2 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet manufacturer.

B. Seam Adhesive: Hot-melt adhesive tape or similar product recommended by carpet manufacturer for sealing and taping seams and butting cut edges at backing to form secure seams and to prevent pile loss at seams.

2.3 CARPET STAIR NOSINGS

A. Provide Ecoglo C Series, C4171, clear anodized Type II Class I, with black non-slip strip and glow stripe.

1. Brightness shall comply with ASTM E2073, DIN 67510 Part 1, and ISO 17398:2004 Clause 7.1.
2. Slip Resistance shall comply with UL410, AS/NZS 4586-1999 and AS/NZ4586 – 2004.
3. Abrasion Resistance shall comply with ASTM B2044 – 97, ASTM B137-95 (2000) and JIS H8682-1:1999.
4. Flammability Resistance shall pass ASTM E162-02 AND ASTM D635-03.

B. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work may be offered in substitution for this product.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet performance. Examine carpet for type, color, pattern, and potential defects.

B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

D. Preparation: Comply with CRI 104, Section 7.3, "Site Conditions; Floor Preparation," and with carpet manufacturer's written installation instructions for preparing substrates.

E. Installation:

1. Direct-Glue-Down Installation: Comply with CRI 104, Section 9, "Direct Glue-Down Installation."
2. Stair Installation: Comply with CRI 104, Section 13, "Carpet on Stairs" for glue-down installation.

F. Comply with carpet manufacturer's written recommendations and Shop Drawings for seam locations and direction of carpet; maintain uniformity of carpet direction and lay of pile. At doorways, center seams under the door in closed position.

G. Cut and fit carpet to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet manufacturer.

H. Extend carpet into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

I. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, non-staining marking device.

J. Install pattern parallel to walls and borders to comply with CRI 104, Section 15, "Patterned Carpet Installations" and with carpet manufacturer's written recommendations.

K. Perform the following operations immediately after installing carpet:

1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet manufacturer.
2. Remove yarns that protrude from carpet surface.
3. Vacuum carpet using commercial machine with face-beater element.

L. Protect installed carpet to comply with CRI 104, Section 16, "Protecting Indoor Installations."

END OF SECTION 096816

SECTION 097720 – FIBERGLASS REINFORCED PLASTIC (FRP) WALL PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Prefinished polyester glass reinforced plastic sheets and adhered to unfinished gypsum wallboard.

1. FRP wall panels and fasteners.
2. PVC trim.
3. PVC wall base.

B. Products Not Furnished or Installed under This Section:

1. Substrate.
2. Resilient Base.
3. Glass-mat gypsum wall board.

1.2 SUBMITTALS

A. Product Data: Submit sufficient manufacturer's data to indicate compliance with these specifications, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.

B. Shop Drawings: Submit elevations of each wall showing location of paneling and trim members with respect to all discontinuities in the wall elevation.

C. Selection Samples: Submit manufacturer’s standard color pattern selection samples representing manufacturer's full range of available colors and patterns.

D. Samples for Verification: Submit appropriate section of panel for each finish selected indicating the color, texture, and pattern required.

1. Submit complete with specified applied finish.
2. For selected patterns show complete pattern repeat.
3. Exposed Molding and Trim: Provide samples of each type, finish, and color.

E. Manufacturers Material Safety Data Sheets (MSDS) for adhesives, sealants and other pertinent materials prior to their delivery to the site (available as downloads for most Marlite’s products at http://www.marlite.com/tech-details.aspx or by contacting Marlite at info@marlite.com).

1.3 QUALITY ASSURANCE

A. Conform to building code requirements for interior finish for smoke and flame spread requirements as tested in accordance with:

1. ASTM E 84 (Method of test for surface burning characteristics of building Materials)
   a. Wall Required Rating – Class [A] [C].

B. Sanitary Standards: System components and finishes to comply with:

1. United States Department of Agriculture (USDA) requirements for food preparation facilities, incidental contact.
2. Food and Drug Administration (FDA) 1999 Food Code 6-101.11.
3. Canadian Food Inspection Agency (CFIA) requirements.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver materials factory packaged on strong pallets.

B. Store panels and trim lying flat, under cover and protected from the elements. Allow panels to acclimate to room temperature (range of 60 to 75°F) for 48 hours prior to installation.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Building are to be fully enclosed prior to installation with sufficient heat (70°) and ventilation consistent with good working conditions for finish work

B. During installation and for not less than 48 hours before, maintain an ambient temperature and relative humidity within limits required by type of adhesive used and recommendation of adhesive manufacturer.

1. Provide ventilation to disperse fumes during application of adhesive as recommended by the adhesive manufacturer.

1.6 WARRANTY

A. Furnish one-year guarantee against defects in material and workmanship from date of Acceptance by Owner.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

A. Marlite; 1 Marlite Drive, Dover, OH 44622. 800-377-1221 FAX (330) 343-4668 Email: info@marlite.com www.marlite.com.

B. Products by other manufacturers that meet the requirements of this specification include but are not limited to:

1. Crane Composites (Kemlite).
2. Glasteel.
3. Fiber-Tech Industries

C. Product:

1. Standard FRP

2.2 PANELS

A. Fiberglass reinforced thermosetting polyester resin panel sheets complying with ASTM D 5319.
   1. Coating: Multi-layer print, primer and finish coats or applied over-layer.
   2. Dimensions:
      a. Thickness – 0.090 “ (2.29mm) nominal
      b. Width - 4'-0” (1.22m) nominal
      c. Length – [10’-0” (3.0m)][8’-0” (2.4m)][As indicated on the drawings] nominal
   3. Tolerance:
      a. Length and Width: +/-1/8 “ (3.175mm)
      b. Square - Not to exceed 1/8 “ for 8 foot (2.4m) panels or 5/32 “ (3.96mm) for 10 foot (2.4m) panels

B. Properties: Resistant to rot, corrosion, staining, denting, peeling, and splintering.
   1. Flexural Strength - 1.0 x 10^4 psi per ASTM D 790. (7.0 kilogram-force/square millimeter)
   2. Flexural Modulus - 3.1 x 10^5 psi per ASTM D 790. (217.9 kilogram-force/square millimeter)
   3. Tensile Strength - 7.0 x 10^3 psi per ASTM D 638. (4.9 kilogram-force/square millimeter)
   4. Tensile Modulus - 1.6 x 10^5 psi per ASTM D 638. (112.5 kilogram-force/square millimeter)
   5. Water Absorption - 0.72% per ASTM D 570.
   6. Barcol Hardness (scratch resistance) of 35 55 as per ASTM D 2583.
   7. Izod Impact Strength of 72 ft. lbs./in ASTM D 256

C. Back Surface: Smooth. Imperfections which do not affect functional properties are not cause for rejection.

D. Front Finish:
   1. Color to be selected from full range of manufacturer’s standard colors.
   2. Surface Texture: Pebbled.

E. Size: 120 inches.

F. Fire Rating: Class A.

2.3 BASE

A. Marlite Base Molding for 0.090” (2.29mm) thick FRP Panels
   1. Color: Match the panel color.
   2. Profiles: Select from below, as required:
      a. M 612 FRP Base Molding, 10’ length
      b. M 651 Inside Corner
      c. M 660 Outside Corner

d. M 620 LH End Cap
e. M 625 RH End Cap

2.4 MOLDINGS

A. PVC Trim: Thin-wall semi-rigid extruded PVC.

1. M 360 Outside Corner, [8’ length][10’ length]
2. M 365 Division, [8’ length][10’ length]
3. M 370 Edge, [8’ length][10’ length]
4. Color: Match panel color.

2.5 ACCESSORIES

A. Fasteners: Non-staining nylon drive rivets.

1. Match panel colors.
2. Length to suit project conditions.

B. Adhesive: Either of the following construction adhesives complying with ASTM C 557.

1. Marlite C-551 FRP Adhesive - Water- resistant, non-flammable adhesive.
2. Marlite C-915 Construction Adhesive - Flexible, water-resistant, solvent based adhesive, formulated for fast, easy application.
3. Titebond Advanced Polymer Panel Adhesive – VOC compliant, non-flammable, environmentally safe adhesive.

C. Sealant:

1. Marlite Brand MS-250 Clear Silicone Sealant.
2. Marlite Brand MS-251 White Silicone Sealant.
3. Marlite Brand - Color Match Sealant.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine backup surfaces to determine that corners are plumb and straight, surfaces are smooth, uniform, clean and free from foreign matter, nails countersunk, joints and cracks filled flush and smooth with the adjoining surface.

1. Verify that stud spacing does not exceed 24” (61cm) on-center.

B. Repair defects prior to installation.

1. Level wall surfaces to panel manufacturer’s requirements. Remove protrusions and fill indentations.

3.2 INSTALLATION

A. Comply with manufacturer's recommended procedures and installation sequence.

B. Cut sheets to meet supports allowing 1/8” (3 mm) clearance for every 8 foot (2.4m) of panel.

1. Cut and drill with carbide tipped saw blades or drill bits or cut with shears.
2. Pre-drill fastener holes 1/8” (3mm) oversize with high speed drill bit.

    a. Space at 8” (200mm) maximum on center at perimeter, approximately 1” from panel edge.
    b. Space at in field in rows 16’ (40.64cm) on center, with fasteners spaced at 12” (30.48 cm) maximum on center.

C. Apply panels to board substrate, above base, vertically oriented with seams plumb and pattern aligned with adjoining panels.

1. Install panels with manufacturer's recommended gap for panel field and corner joints.

    a. Adhesive trowel and application method to conform to adhesive manufacturer’s recommendations.
    b. Drive fasteners for snug fit. Do not over-tighten.

D. Apply panel moldings to all panel edges using silicone sealant providing for required clearances.

1. All moldings must provide for a minimum 1/8 “ (3mm) of panel expansion at joints and edges, to insure proper installation.
2. Apply sealant to all moldings, channels and joints between the system and different materials to assure watertight installation.

3.3 CLEANING

A. Remove excess sealant from panels and moldings. Wipe panel down using a damp cloth and mild soap solution or cleaner.

B. Refer to manufacturer's specific cleaning recommendations Do not use abrasive cleaners.

1

2 END OF SECTION 097720

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes surface preparation and the application of paint systems on the following interior substrates:

1. Concrete.
2. Concrete masonry units (CMU).
3. Steel.
4. Wood.
5. Gypsum board.
6. Spray-on Acoustic Insulation

B. Related Sections include:

1. 042000, Unit Masonry.
2. 064023, Interior Architectural Woodwork.
3. 079200, Joint Sealants.
4. 081213, Hollow Metal Frames.
5. 090000, Color Schedule.
6. 092900. Gypsum Board Assemblies.
7. 096253, Resilient Stage Flooring Assemblies (for stage floor coating)

1.2 DEFINITIONS

A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.

B. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

C. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

D. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.

E. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.

F. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

G. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

B. Samples: For each type of paint system and in each color and gloss of topcoat.

C. Product List: For each product indicated. Include printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to products listed in other Part 2 articles for the paint category indicated.

2.2 PAINT, GENERAL

A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."

B. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 150 g/L.
3. Dry-Fog Coatings: 400 g/L.
4. Primers, Sealers, and Undercoaters: 200 g/L.
5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
6. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
7. Pretreatment Wash Primers: 420 g/L.
8. Floor Coatings: 100 g/L.
9. Shellacs, Clear: 730 g/L.
10. Shellacs, Pigmented: 550 g/L.

D. Low-Emitting Materials: Interior paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Colors: As indicated in Color Schedule 090000.

2.3 BLOCK FILLERS

A. Block Filler/Surfacer, Latex Acrylic, Interior/Exterior: MPI #4.

1. Sherwin-Williams Acrylic Latex Primer/Surfacer A24W00200/LX01W0200.
2. Benjamin Moore Latex Primer/Filler: 0608/K608.
3. PPG Architectural Surfacer/Filler: 4-100XI.

2.4 CONCRETE/MASONRY PRIMERS/SEALERS

A. Primer Sealer, Latex, Interior: MPI #50.

1. Sherwin-Williams Interior Latex Primer: C162.
2. Benjamin Moore Interior Latex Primer: N534/K534.
3. PPG Architectural, Dulux: 59113.

B. Primer, Alkali Resistant, Water Based: MPI #3.

1. Sherwin-Williams Concrete/Masonry Primer: A24W8300/LX02W0050.
2. Benjamin Moore Concrete/Masonry Primer: K958.
3. PPG Architectural: 17-921XI Series.

2.5 METAL PRIMERS

A. Primer, Rust-Inhibitive, Water Based Acrylic: MPI #107.

1. Sherwin-Williams Latex Primer B66W01310.
2. Benjamin Moore Latex Primer HP04/FP04.
3. PPG Architectural, Pitt-Tech: 90-712.

B. Primer, Galvanized, Water Based Acrylic: MPI #134.

1. Sherwin-Williams Latex Primer B66W00011.
2. Benjamin Moore Latex Primer HP04/FP04.
3. PPG Architectural, Dulux: 1535.

2.6 WOOD/DRYWALL PRIMERS/SEALERS

A. Primer, Latex, for Interior Wood: MPI #39.

1. Sherwin-Williams Latex Primer B51W00450.
2. Benjamin Moore Latex Primer 027.
3. PPG Architectural: 17-921.

B. Primer Sealer, Latex, Interior: MPI #50.

1. Sherwin-Williams Drywall Primer C152.
2. Benjamin Moore Latex Primer N534/K534.
3. PPG Architectural, Dulux: 59113.

2.7 WATER-BASED PAINTS

A. Latex Acrylic, Interior, High Performance Architectural, Semi-Gloss (Gloss Level 5): MPI #141.

1. Sherwin-Williams: K38W00351.
2. Benjamin Moore Acrylic: HP29/FP29.
3. PPG Architectural, Dulux Diamond: 13210.

B. Latex, Interior, Flat (Gloss Level 1): MPI #143.

1. Sherwin-Williams, Emerald: K36W00451.
2. Benjamin Moore Waterborne 547/K547.
3. PPG Architectural: 9-100.

2.8 FLOOR COATINGS

A. Sealer, Water Based, for Concrete Floors: MPI #99.

1. Sherwin-Williams H&C Concrete and Masonry Waterproofing Sealer: 50.048054.
2. PPG Architectural: 4-6200.
3. Behr Paint: 985.

B. Water Based, for Concrete Floors: MPI #60.

1. Sherwin-Williams Armorseal Tread-Plex: B90W111.
2. PPG Architectural, Sico: 261-501.
3. Kelly-Moore, DuraProxy Plus: 1786-122.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Masonry (Clay and CMU): 12 percent.
3. Wood: 15 percent.
4. Gypsum Board: 12 percent.
5. Plaster: 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."

B. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.4 CLEANING AND PROTECTION

A. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

B. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 INTERIOR PAINTING SCHEDULE

A. Concrete Substrates, Traffic Surfaces:

1. Water-Based Clear Sealer System:

a. First Coat: Sealer, water based, for concrete floors, MPI #99.
b. Topcoat: Sealer, water based, for concrete floors, MPI #99.

B. Steel Substrates:

1. High-Performance Architectural Latex System:

a. Prime Coat: Shop primer specified in Section 051200 "Structural Steel Framing" where substrate is specified.
b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.

c. Topcoat: Latex, interior, high performance architectural, semi-gloss (Gloss Level 5), MPI #141.

C. Wood Substrates: Including wood trim, architectural woodwork.

1. High-Performance Architectural Latex System:

a. Prime Coat: Primer, latex, for interior wood, MPI #39.
b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.
c. Topcoat: Latex, interior, high performance architectural, semi-gloss (Gloss Level 5), MPI #141.

D. Gypsum Board Substrates:

1. High-Performance Architectural Latex System:

a. Prime Coat: Primer sealer, latex, interior, MPI #50.
b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.
c. Topcoat: Latex, interior, high performance architectural, semi-gloss (Gloss Level 5), MPI #141.

E. CMU Substrates:

1. High-Performance Architectural Latex System:

a. Block Filler: Block filler, latex, interior/exterior, MPI #4.
b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.
c. Topcoat: Latex, interior, high performance architectural, semi-gloss (Gloss Level 5), MPI #141.

END OF SECTION 099123

SECTION 099600 - HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes surface preparation and application of high-performance coating systems on the following substrates:

1. Exterior Substrates:

a. Steel.
b. Galvanized metal.
c. Exterior Insulation and Finish System (EIFS).
d. Concrete.

B. For MPI (Master Painters Institute) product designations go to www.specifyingpaint.com. All acceptable products for each designated number are listed on this website.

1.2 DEFINITIONS

A. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523. Also identified as “satin”.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include preparation requirements and application instructions.

B. Samples: For each type of coating system and in each color and gloss of topcoat indicated.

C. Product List: For each product indicated, include printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Coatings: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to products listed in other Part 2 articles for the paint category indicated.

2.2 HIGH-PERFORMANCE COATINGS, GENERAL

A. MPI Standards: Provide products that comply with MPI standards indicated and are listed in "MPI Approved Products List."

B. Material Compatibility:

1. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a coating system, provide products recommended in writing by manufacturers of topcoat for use in coating system and on substrate indicated.
3. Provide products of same manufacturer for each coat in a coating system.

C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction.

1. Flat Paints and Coatings: 50 g/L.
2. Non-flat Paints and Coatings: 150 g/L.
3. Primers, Sealers, and Undercoaters: 200 g/L.
4. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: 250 g/L.
5. Zinc-Rich Industrial Maintenance Primers: 340 g/L.

D. Colors: Match Architect's samples.

2.3 METAL PRIMERS

A. Primer, Acrylic, for Metal: MPI #107.

1. Pro-Cryl Primer B66A310, by Sherwin-Williams, or equivalent product.

2.4 STEEL COATINGS

A. Acrylic, Satin Gloss: MPI #154.

2.5 EIFS SURFACES

A. As recommended by EIFS Manufacturer.

2.6 CONCRETE

A. Acrylic, same matching EIFS.

2.7 CONCRETE FLOOR SLABS

A. Epoxy-Resin Binder/Matrix:

Provide a clear two-component compatible system epoxy resin binder consisting of: (1) a liquid blend of a biphenyl-based epoxy resin and an aliphatic polyglyceridyl ether, and (2) a liquid blend of two modified amine curing agents, which individually cures the epoxy resin at room temperature to a glossy smooth film.

The aggregate floor system to be Royal Coat's Stone Chip high build flooring system or equivalent product meeting these Specifications.

B. Product Properties:

1. (EPOXY RESIN) Base Coat / Build Coat
   Viscosity (kinematic), at 77 degrees F, centipoises ASTM D445 3000 to 5000
   Weight per epoxide, grams ASTM D1652 205 to 225
   Color (Gardner Color Scale), maximum ASTM D1544 5
   Weight per gallon, pounds ASTM D1475 9.46 - 9.56

2. COMPONENT B (CURING AGENT)
   Viscosity (kinematic), at 77 degrees F, centistokes ASTM D445 75 to 125
   Weight per gallon, pounds ASTM D1475 7.50 to 7.60 SECTION 09 67 23.13 Page 4
   REPLACE POOL DECK SURFACE BLDG 289 6200771 PROPERTY TEST METHOD
   REQUIREMENT Color (Gardner Color Scale), maximum ASTM D1544 8

C. Cured Epoxy Binder

1. Combine components A and B in the proportions specified by the manufacturer to form a clear compatible system immediately on mixing. Cure combined components to a clear film possessing a glossy, nongreasy surface at relative humidities less than 80 percent, having the following properties after curing 24 hours at 77 degrees F, followed by 24 hours at 125 degrees F:

   PROPERTY TEST METHOD REQUIREMENT

   Tensile strength, psi* at test temperature: 77 degrees F ASTM D638 4500 to 6500

   Tensile elongation, percent* at test temperature: 77 degrees F ASTM D638 20 to 40

   Water absorption, percent 24 hours at 77 degrees F, maximum ASTM D570 0.40

   Hardness, Shore D ASTM D2240 74 to 82 Linear shrinkage, inch/inch maximum
   ASTM C881/C881M 0.006

   Shrinkage, glass bow, inch divergence, maximum ASTM A990 0.016

   Coefficient of linear thermal expansion, inch/inch/degree C, maximum

2. Aggregate:

   Provide aggregate in the form of a multi-colored shaved granite flake recommended by the resinous flooring aggregate manufacturer.

3. Surface Sealing Coat:

Provide non-ambering aliphatic Polyaspartic urethane surface sealer. Provide surface with some slip resistance, a 150-grit aluminum oxide aggregate provided only in areas requested.

Select surface texture and slip resistance from samples provided by Applicator.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

B. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Beginning coating application constitutes CMR's acceptance of substrates and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

B. Clean substrates of substances that could impair bond of coatings, including chalking, dust, dirt, rust, oil, grease, loose and incompatible paints and encapsulants.

1. Remove incompatible primers and re-prime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.

3.3 APPLICATION

A. Apply high-performance coatings according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" or manufacturer's printed instructions.

B. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

3.4 CLEANING AND PROTECTION

A. Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.

B. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

3.5 HIGH-PERFORMANCE COATING SCHEDULE

A. Steel Substrates:

1. Acrylic System:

a. Prime Coat: Primer, Acrylic, for Metal: MPI #107.
b. Intermediate Coat: Acrylic, Satin Gloss: MPI #154.
c. Topcoat: Acrylic, Satin Gloss: MPI #154.

B. Galvanized-Metal Substrates:

1. Acrylic System:

a. Prime Coat: Primer, Acrylic, for Metal: MPI #107.
b. Intermediate Coat: Acrylic, Satin Gloss: MPI #154.
c. Topcoat: Acrylic, Satin Gloss: MPI #154.

C. EIFS Substrates:

1. As recommended by EIFS manufacturer, subject to the requirements of Section 072419 of this spec, including but not limited to the contact angle of water adhesion exhibited and documented for the Basis-of-Design product (125 degrees), and applied by EIFS subcontractor.

D. Concrete:

1. Acrylic, matching EIFS finish, where noted.

E. Concrete Floor Coating:

1. Epoxy Floor System:

a. Epoxy-Resin Binder/Matrix.
b. Surface Sealing Coat.

END OF SECTION 099600

SECTION 099800 – EXHIBIT TANK COATING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Polymer coating system for coloring & smoothing walls of architectural scale tanks over concrete & crystalline capillary waterproofing where indicated.

1.2 RELATED SECTIONS

A. Cast-in-Place Concrete is specified in Section 033000

B. Exhibit Tank Glazing is specified in Section 08 84 00

1.3 REFERENCES

A. ACI 515.1R – A Guide to the Use of Waterproofing, Damp-proofing, Protective and Decorative Barrier Systems for Concrete.

B. ASTM D 4138 - Measurement of Dry Film Thickness of Protective Coating Systems by Destructive Means.

C. ASTM D 4258 – Standard Practice for Surface Cleaning Concrete for Coating.

D. ASTM D 4259 – Standard Practice for Abrading Concrete.

E. ASTM D 4414 – Standard Practice for Measurement of Wet Film Thickness by Notch Gages.

F. ASTM D 4541 – Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.

G. ASTM E 1907 – Standard Practices for Determining Moisture-Related Acceptability of Concrete Floors to Receive Moisture-Sensitive Finishes.

H. ASTM F 1869 – Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.

I. International Concrete Repair Institute (ICRI) Technical Guideline No. 03730 - Surface Preparation Guidelines for the Repair of Deteriorated Concrete Resulting From Reinforcing Steel Corrosion.

J. International Concrete Repair Institute (ICRI) Technical Guideline No. 03732 – Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.

K. National Association of Corrosion Engineers International, NACE RP 0188 - Discontinuity (Holiday) Testing of Protective Coatings.

L. National Association of Corrosion Engineers International, NACE RP 0288 – Inspection of Linings on Steel and Concrete

M. SSPC-SP 12/NACE 5 – Surface Preparation and Cleaning of Steel and Other Hard Materials by High- and Ultrahigh-Pressure Water Jetting Prior to Recoating

1.4 SUBMITTALS

A. Comply with project Submittal Procedures.

1. Product substitutions to be submitted by Contractor and approved by Architect at least 10 days before bid date
2. Proposed substitutions shall have not less than 5-years application history in at least 3 similar exterior installations. Provide contact information for the owners of the facilities in which the systems have been installed.

B. Product Data: Submit manufacturer's product data, including physical properties, surface preparation, application instructions, and curing instructions.

C. Test Reports: Submit manufacturer's test reports of in-place testing performed by an independent testing agency

D. CMR shall submit a list of three polymer lining system projects, with at least three years of successful service history, including project name and location, names and telephone numbers of owner and engineer, and description of products used, substrates, and application procedures.

E. CMR shall submit certification letter stating that all products (, primer, flexible underlayment or epoxy void filler, epoxy saturant, epoxy topcoat and urethane sealcoat) are from a single source. Single source is defined as a single entity (person or company) that owns all rights to all system components.

F. Applicator Qualifications: Submit qualifications of applicator.

1. Certification by the manufacturer stating that the applicator is trained and approved in the application of the specified products.
2. Certification of a minimum of three years' experience in successful application of epoxy laminate or tank lining systems similar or identical to the systems specified herein.

G. For interior coatings, documentation including printed statement of VOC content.

1.5 QUALITY ASSURANCE

A. Applicator Qualifications:

1. Applicators must be trained and approved by the manufacturer in the application of the specified products.
2. Contractor must employ persons trained for the application of the specified products.

B. Pre-Application Meeting: Convene a pre-application meeting 2 weeks before the start of application of the Fluid-Applied Waterproofing for Aquarium Tanks (Polymer Lining System). Require attendance of parties directly affecting work of this section, including the Contractor,

Engineer, applicator, and manufacturer's technical service representative. Review surface preparation, application, curing, field quality control, and coordination with other work.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Storage:

1. Store materials in accordance with manufacturer's instructions.
2. Keep containers sealed until ready for use.
3. Store materials in a cool, dry environment.
4. Storage Temperature of Polymer Lining System Materials: 40 to 80 degrees F.

C. Handling: Protect materials during handling and application to prevent damage.

1.7 ENVIRONMENTAL CONDITIONS

A. Do not apply materials under the following conditions:

1. Temperatures exceeding the manufacturer's recommended maximum or minimum allowable.
2. Dusty or smoke-laden atmosphere.
3. Damp or wet conditions.

B. Provide temporary enclosure and electric heating as required to maintain conditions within Manufacturer’s installation requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Madewell Products Corporation, 7561A Industrial Court, Alpharetta, Georgia 30004. Phone (770) 475- 8199. Fax (770) 475-8167. Internet: www.madewell.net

B. Sta-Crete SS1500"; Epmar Corporation, 13210 E. Barton Circle, Santa Fe Springs, CA 90670 (310) 946-8781.

C. Aquafin, Inc 505 Blue Ball Road, #160. Elkton, MD 21921. Phone (800) 394-1410

D. Alternative manufacturers subject to Owner and Exhibit Designer approval.

2.2 PAINT/COATING SYSTEM FOR AQUARIUM TANKS

A. General

1. Primer, Void filler/surfacer, topcoat and urethane sealcoat shall be procured from a single manufacturer.
2. Materials must be compatible with substrate and with each other. Materials must have a minimum of three years of successful service history in fresh and salt water aquarium and zoo tanks.
3. Materials must be compatible with substrate and with each other. Materials must have a minimum of three years of successful service history in fresh and salt water aquarium and zoo tanks.
4. Alternate products meeting performance criteria will be considered.

B. Epoxy Primer/Sealer: Madewell 927 Penetrating Epoxy Primer/Sealer

1. Composition: 100 percent solids epoxy
2. Thickness: 8 mils at 200 square feet per gallon.
3. Number of Components: 2.

C. Flexible Epoxy Void Filler and Surfacer: Madewell 806 Thixotropic Epoxy Surfacer and Void Filler.

1. Composition: 100 percent solids epoxy paste.
2. Thickness: Minimum of 40 mils.
3. Number of Components: 2.

D. Epoxy Saturated Fiberglass: Madewell 1312E Epoxy Saturant

1. Composition: 1.5 ounce chopped strand mat fiberglass and 100% solids modified epoxy saturant
2. Number of Components: 2.
3. Color: Translucent blue

E. Epoxy Topcoat: Madewell 1312S Epoxy Coating System.

1. Composition: 100% Solids Epoxy Coating
2. Thickness: Two 10 mil coats
3. Number of Components: 2.
4. Finish: Gloss
5. Color: Custom colors to match sealcoat, as selected by architect

F. Urethane Sealcoat (all systems): Madewell 1450 Aliphatic Polyurethane Coating

1. Composition: 60% Solids Aliphatic Polyurethane Coating
2. Thickness: 4 to 6 mils WFT, 2.5 to 3.5 mils DFT
3. Number of Components: 2.
4. Finish: Gloss
5. Color: 2 Custom colors as selected by the Architect

PART 3 - EXECUTION

3.1 EXAMINATION

A. Coordinate Examine surfaces to receive restoration mortar or primer.

1. Check for previously-applied coatings, structural flaws, cracks, voids, honeycombs, grease and oil contamination, salt contamination and pH.
2. Previously applied coatings shall be removed by abrasive or high-pressure water jetting, as specified herein.
3. Structural flaws, cracks, voids and honeycombs shall be repaired to the satisfaction of the Engineer and manufacturer's technical service representative.
4. Grease and oil contamination shall be removed by means of detergents, degreasers, steam and/or chemical agents, followed by rinsing with copious amounts of fresh potable water.
5. All detectable soluble salts shall be removed by means of rinsing with copious amounts of fresh potable water.

B. Notify the Architect in writing if surfaces are not acceptable. Do not begin surface preparation or application until unacceptable conditions have been corrected.

C. Provide the Architect with a minimum of 3-days advance notice of completion of surface preparation and start of application.

D. Before application of each material, surfaces to be lined will be inspected by the Architect and the manufacturer's technical service representative. Correct defects or deficiencies before application of subsequent material.

E. Inspection by the Architect and the manufacturer's technical service representative or the waiver of inspection of any portion of the work shall not relieve the Contractor of responsibility to perform the work as specified.

3.2 SURFACE PREPARATION

A. Prepare surfaces in accordance with manufacturer's instructions.

1. Remove existing liners at concrete tanks using 40,000 psi rotary head water blasting equipment and grinding.
2. Remove existing degraded gelcoat and/or liners at fiberglass tanks using angle grinders with 24 grit pads

    a. Cleaning: Clean surfaces by Low-Pressure Water Cleaning according to the requirements of SSPC-SP 12/NACE 5, unless otherwise directed by the manufacturer in writing, to remove all unsound concrete, contaminants, dirt, debris, and/or existing coatings or detectable soluble salts.

B. Inspection:

1. Inspect cleaned surfaces to identify and mark cracks, and joints.
2. Inspect surfaces for soundness by tapping with a hammer, checking for loose aggregate and soft spots.

C. Prepare surfaces to a minimum CSP 3 per ICRI Technical Guideline 03732.

D. Repair minor defects in concrete such as bug holes, surface cracks and formwork offsets by filling with coating manufacturer's recommended patching material and/or grinding to form a smooth surface.

E. Where cracks, construction joints or other defects have been previously repaired or coated with crystalline capillary waterproofing ensure surface to receive coating is smooth and sound.

3.3 APPLICATION OF EPOXYPRIMER/SEALER

A. Apply epoxy primer/sealer to prepared substrate at a coverage rate of 200 sf/gallon (8 mils).

B. Concrete substrate should have a dark, wet appearance when adequately primed/sealed. If small areas appear to be dry after initial application of epoxy primer/sealer, re-apply epoxy primer/sealer to those areas.

C. Surfaces are ready to be lined when epoxy primer/sealer has completely achieved a dry-to-the-touch condition.

3.4 APPLICATION OF EPOXY SATURATED FIBERGLASS

A. While the primer is still tacky apply the layer of fiberglass to the surface (1.5 ounce chopped strand mat). Lay straight and wrinkle free.

B. Wet wall with epoxy saturant using ½ nap or 3/8 nap rollers area needs to be completely saturated (no white of mat left). The area should be checked and air rollers used to remove any trapped air bubbles.

C. Allow epoxy to cure a minimum of 12 hours.

D. Grind surface with Zek wheels or 24 grit abrasive wheels to remove any voids or rough areas and smooth the seams of the fiberglass.

E. Clean the surface and complete any repairs needed.

3.5 APPLICATION OF EPOXY TOPCOAT and URETHANE SEALCOAT (all systems)

A. Apply first coat of epoxy topcoat by roller or spray to a minimum of 10 mils WFT. Allow first coat to become tack free before application of second coat.

B. Sand first coat after it becomes tack free (with up to 40 grit sandpaper) and/or clean all surfaces as required to achieve desired surface smoothness.

C. Apply second coat of epoxy topcoat by roller or spray to a minimum of 10 mils WFT.

1. At above water horizontal walking surfaces, apply by roller to form “orange peel” texture for slip resistance

D. Inspect second coat, sand (with up to 100 grit sandpaper), and repair as required.

E. Apply urethane sealcoat by roller to a minimum of 4 to 6 mils WFT. Allow epoxy topcoat to become tack free prior to application, but no later than 72 hours after application of epoxy topcoat.

1. At above water horizontal walking surfaces, maintain “orange peel” texture for slip resistance.

F. Allow urethane sealcoat to cure a minimum of 7 days at 72o F before putting into immersion service.

3.6 TERMINATION, PENETRATION, CRACK TREATMENT, TRANSITION AND ATTACHMENT DETAILS FOR TANK COATING

A. For terminations from coating to bare concrete, before surface preparation is begun, sawcut and chip out a shallow key for the Epoxy at the transition line or as recommended by the coating manufacturer and die the coating system into the key.

B. Details for termination of tank waterproofing at pipe penetrations shall be as recommended by the Manufacturer.

C. Termination of tank waterproofing at acrylic tank window rebates shall be as indicated on Sheet A9.70. Where tank coating is used as the epoxy surface within the window rebate, prior to placing the window panels, the laminate surfaces to be sealed with silicone sealant should be sanded smooth and vacuumed clean to ensure that the sealant will adhere properly. The finish coat in this area should be the epoxy topcoat only. Do not apply the Urethane Sealcoat within the window rebates. Coordinate application with the acrylic tank window Installer.

D. Provide fillet of epoxy void filler below the waterproofing system at all inside corner transitions as recommended by the manufacturer.

E. Any changes to or modifications of any of the details listed above shall be requested in writing before the beginning of installation of the tank waterproofing. Approval shall be given only after review and approval by the manufacturer and the architect/engineer. Any increase in the cost of the detail due to the change(s) shall be borne by the contractor.

3.7 FIELD QUALITY CONTROL

A. Field Quality Control Testing: Performed and documented by the Approved Contractor in the presence of the manufacturer's technical representative.

B. Test Patch: The contractor shall install a 4' x 10' test patch to be tested in accordance with C, D and E below before application work begins.

C. Perform Destructive Dry Film Thickness Tests in accordance with the principles of ASTM D 4138:

1. Perform 1 test on finished composite for every 1,000 square feet of surface to be lined. If the thickness is correct, no further testing is required for that area.
2. If the initial thickness test does not indicate correct composite thickness, an additional 4 measurements will be made, the average of which must equal minimum specified thickness, although individual measurements may under run this amount by a maximum of 20 percent.
3. Any area that does not meet the specified thickness as tested in 1. and 2. above, shall receive additional composite waterproofing thickness (depending on the time and environment, additional surface preparation may be required).
4. If the areas tested are of proper thickness, destructive test sites shall be repaired with the composite waterproofing system specified at the contractor's expense prior to placing the system into service.

D. Perform Spot Adhesion Testing of Tank Waterproofing System to Substrate in accordance with the principles of ASTM D 4541 using a Madewell Adhesion Tester in accordance with manufacturer's instructions:

1. Perform minimum of 1 uniaxial pull-off adhesion test for every 1,000 square feet of surface lined. Minimum test value for Systems 1, 2 and 3 shall be equal to or greater than 350 psi. Minimum test value for Systems 4, 5 and 6 shall be equal to or greater than 145 psi.
2. Remove and replace areas not meeting required minimum adhesion requirement.
3. If the condition of the substrate is such that minimum pull-off adhesion requirement cannot be met by removal of the upper 1/4" of the substrate, work shall not proceed until a course of corrective action has been determined that will effectively produce the required adhesion results. When an effective course of remedial action has been determined, the owner's representative and the contractor shall negotiate a mutually agreeable settlement to cover the costs associated with the surface evaluation and remedial action.

E. Visual Inspection for Holidays in Composite Waterproofing System:

1. Visual Inspection: Perform visual inspection for holidays in Composite Waterproofing System.
2. Mark areas identified for repair and reapplication of Composite Waterproofing System.
3. Repair areas marked according to manufacturer's instructions.

END OF SECTION 099800

SECTION 100000 - MISCELLANEOUS SPECIALTIES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division -1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK:

A. This section includes all miscellaneous specialty items not included by any specific building trade group. Items that follow are the responsibility of the general contractor whether he supplies the labor to install them or lets the work of furnishing and installation to others.

B. Scope: This contractor shall provide all items, articles, materials, operations, or methods listed, mentioned, or scheduled on the drawings, or hereinafter specified, including all labor, materials, equipment and incidentals necessary and required for their completion.

1.3 QUALITY ASSURANCE:

A. Field Measurements: Take field measurements for items to be built-in prior to preparation of shop drawings and fabrication. This is not necessary for manufactured items or free-standing items.

B. Manufacturers as listed shall be used as a guide for design and quality. Other manufacturers' products of equal design and quality may be used upon written approval of the Architect. Where more than one manufacturer is listed for an item in the products schedule, one may be indicated as a guide for specification and for detailing.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's specifications, details, and installation instructions for manufactured products.

B. Shop Drawings: Submit for approval specified copies of shop drawings, catalog cuts, and necessary information for each item before work is commenced. Include plans, elevations, details, anchorage and accessory items, as needed for approval, fabrication, and installation.

C. Setting Drawings: Provide setting drawings, templates, instructions, and directions or installation of anchorage devices in other work.

PART 2 – PRODUCTS

2.1 Index of Miscellaneous Specialty Items:

A. Specification for each item follows in Part 4 - Schedule of Miscellaneous Specialty Items:

1. Fire Extinguisher Cabinets (FEC).
2. Toilet Accessories.

3. Roller Shades.
4. Toilet Compartments.
5. Interior Signage.
6. Metal Access Door.
7. Marker Boards and Tack Boards.
8. Expansion Joint Covers.
9. Entrance Floor Mats and Frames (RCM).
10. Dock Bumpers.
11. Folding Partitions.
12. Suspended Curtain Track.
13. Composite Manhole Covers.
14. Coiled Wire Fabric Curtain System.

B. Schedule of Miscellaneous Specialty Items:

1. Fire Extinguisher Cabinets

Locations:

Refer to Sheets A-2.21 A through A-2.23 B.

Mounting Height:

Top of cabinet shall be 5'-4" a.f.f.

Available Manufacturers:

Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to the following:

Larsen's Manufacturing Company
J.L. Industries
Potter-Roemer

Cabinets:

Heavy gauge, white baked enamel box with clear aluminum trim and door. Hardware to suit cabinet's trim and door style. Mitered corners with extruded or fabricated aluminum trim.

Available Manufacturers:

Subject to compliance with requirements, manufacturers offering products that may be provided include, but are not limited to the following:

Larsen's Manufacturing Co. FS AL 2409-5R with 1 ¼" square trim semi-recessed, vertical duo design (Basis-of-Design).
Guardian Fire Equipment.
Babcock-Davis.

Size:

24” x 9 ½” x 4 ¾”.

Door Finish:

Clear satin anodized.

Installation:

Block-out as required to receive units.
In gypsum board walls, line the interior of the cabinet “cut-out” with 5/8” type “X” gypsum board, level 1 finish.

Fire Extinguishers:

Provide ABC Type fire extinguishers in all cabinets.

2. Toilet and Miscellaneous Accessories

Location:

Shown on Sheets A-4.11 A and B, A-4.12, A-4.13.

Available Manufacturers:

Subject to compliance with requirements, provide toilet accessories by one of the following:

a. Bobrick Corp.
b. Bradley Corp.
c. American Specialties, Inc.

Material:

Stainless steel with satin finish unless otherwise noted. Model numbers based on Bradley., U.O.N.

Schedule of Accessories:

a. Grab Bar: Bradley 812 Series, 1 1/2” inch diameter with peened surface, 36” long, conceal mounting flanges with snap flange covers (flush valve side).
b. Grab Bar: Bradley 812 Series, 1 1/2” inch diameter with peened surface, 42” long, conceal mounting flanges with snap flange covers (partition side, horizontal).
c. Grab Bar: Bradley 812 Series, 1 1/2” inch diameter with peened surface, 48” long, conceal mounting flanges with snap flange covers (corner, horizontal).
d. Grab Bar: Bradley 812 Series, 1 1/2” inch diameter with peened surface, 18” long, conceal mounting flanges with snap flange covers (side, vertical).
e. Hand Dryer: By Owner. GC install.
f. Paper Towel Dispensers: By Owner. GC install.
g. Paper Towel Waste Disposer: Bradley 355
h. Liquid Soap Dispensers: By Owner. GC install.
i. Dual Roll Toilet Paper Dispensers: By Owner. GC install.
j. Coat/Clothes Hook: By Toilet Partition supplier (one per stall door).
k. Feminine Napkin Receptacle: By Owner. GC install (one per stall in Women’s Toilets).
l. Mirror: 24” wide x 36” high, Bradley 747-024360.
m. Mirror: 24” wide x 60” high, Bradley 747 Series.
n. Adult Changing Station: By Owner. GC install.

o. Mop Rack: By Owner. GC install. (one per custodial closet)
p. Shower Seat: Bradley 9562 Series

3. Roller Shades

Locations:

Provide Roller Shades in all designated spaces.

Size:

Units to mount at detailed on Sheet A-7.15. Heights of shades to match the window unit. Widths to be the width of the glass plus one inch.

Available Manufacturers:

Subject to compliance with requirements, manufacturers offering products that may be provided include, but are not limited to the following:

Draper Shade & Screen Co., Inc. (Basis-of-Design).
Hunter Douglas Window Fashions.
Levolor Contract – A Newell Company.

Materials:

a. Fabrics shall be PVC coated polyester similar to Draper Series 2600/2900 by Phifer. Material will be 75% to 90% opaque.
b. Provide all required mounting brackets and a 4-5/8" extruded head box for surface-mounting.
c. Provide stainless steel bead chain clutch operation for all window shades.

Color:

To be selected from manufacturer's full range of fabrics.

Installation:

a. Examine substrates, areas and conditions for compliance with requirements for installation tolerances and operational clearances. Proceed with installation only after unsatisfactory conditions have been corrected.
b. Install roller shades level, plumb, square and true according to the manufacturers written instructions and located so that the shade band is not closer than 2" from the interior face of glass. Allow clearance for window operation hardware.
c. Adjust and balance roller shades to operate smoothly, easily, safely and free from binding or malfunction throughout the entire operational range.
d. Clean roller shade surfaces after installation according to the manufacturers written instructions.
e. Replace damaged roller shades that cannot be repaired in a manner approved by the Architect.
f. Demonstrate and train the Owner's maintenance personnel to adjust, operate and maintain system.

4. Toilet Compartments:

Location and Size:

Refer to Enlarged Plans on sheet A-4.11 A and B, A-4.12, A-4.13.

Materials:

Solid Plastic: High density, solid polymer resin with homogenous color throughout. Provide material not less than 1" thick with seamless construction with edges eased. Provide integral metal heat sinks at the bottom of doors and panels that do not extend to the floor.

Provide Extra Privacy panels; Height: 71-1/2 inches (1816 mm) high and mounted at 4 inches (102 mm) above the finished floor.

Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finish is to match hardware, with theft-resistant-type heads and nuts. For concealed anchors, use stainless steel and seal holes with elastomeric or silicone sealant.

Provide all Floor-Mounted and Overhead-Braced Units. Provide continuous aluminum strikes (length of door panel).

Provide one stainless steel coat hook per stall. Accessible stalls shall have hooks mounted at 46 inches above the floor.

Color:

Refer to Section 090000 "Color Schedule".

Hardware:

Spring-loaded concealed door hinges. Coat hook in each stall, vinyl bumper strips at doors stops and latches. Provide Occupancy Indicator on each door latch.

Installation:

Toilet Partitions: Shall be secured with vandal resistant machine screws with expansion anchors at masonry and tile walls and with toggle bolts at hollow walls and expansion anchors at other walls. Stiles will be secured to floor with a minimum of two 3/8" diameter threaded rods set in expansion anchors. Provide stainless steel base trim to conceal floor anchorage and leveling devices.

Partition Doors: Shall be provided at all toilet compartments.

Available Manufacturers:

Subject to compliance with ADA requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to the following:

Republic
Scranton Products
ASI Group

5. Signage – Interior:

Location:

Refer to Door Schedule on Sheet A-9.3.

Size:

6” square; except Toilet signs are 6” wide by 8” high.

Submittals:

Provide shop drawings showing color selections sign configurations and details. Provide a message list for each sign which shall include large scale details of symbols, wording, lettering, room numbers, and Braille layout for approval by architect and owner.

Materials:

Sign background (to be comprised of two laminate plies of cast acrylic sheet. The face ply to be 1/32" thick non-glare finished optically correct acrylic. Background color is to be applied to the subsurface as well as silk screened graphics when required. The substrate ply shall be 1/8" black acrylic.

a. All edges to be routed smooth and square.

Tactile graphic appliqué to be comprised of 1/32" modified engraving acrylic with the following properties.

a. Color composition incorporated into material.
b. High bond (3M) adhesive backing (see adhesive specs.)
c. Izod impact strength, 2ft. lbs/in.
d. Tensile strength, 7,000 psi before break.
e. Specific gravity, 1.11.
f. Rockwell hardness, R114, M45.
g. Coefficient of thermal expansion, 5.0 x 10-5

Appliqué material to be mechanically engraved (cut) on substrate, to form a 1/32" min. raised letter form with a +/-15-degree beveled profile or draft.

All grade II Braille to be displayed in embedded raster .0625" in dia. of clear acrylic for interior applications and clear glass raster for exterior applications as required. Raster voids are to be precision milled into the substrate material in order to allow the proper raster height and inter-dot spacing as specified above.

Sign types below (Owner to provide numbering):

<u>Type A;</u>

Text Information Sign (Text matches name of room designated on Drawing A-9.1).

Style:

2 ply laminated construction with screen printed message and background color. Provide 2¼” high slot for changeable printed information on vinyl insert. Provide one insert per sign, with copy as directed by the Owner.

Type B;

Same as Type A, without the insert slot.

Type C;

Accessible Toilet Sign Text:

"Women" -- Mount to the right of the masonry opening.
"Men" -- Mount to the left of the masonry opening.
"Toilet".

Available Manufacturers:

Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to the following:
Allen Industries, Greensboro, NC (formerly Andco).www.allenindustries.com
Corum Signs, Jamestown, NC.corumsigns@triad.rr.com(email address).
Signage Industries Corporation, Archdale, NC. www.signageindustries.com
AOA Signs, Yadkinville, NC www.AOASigns.com.

Color:

Refer to Section 090000 "Color Schedule".

Mounting:

All sign products shall be mounted or installed in one or combination of the two following methods:

Shim Plate Mounting, this method incorporates an .080 aluminum plate milled 1/8" smaller overall than the corresponding plaque or sign. The mounting shim plate is to be painted to match the plaque. Shim plate and then affixed to the porous wall surface with 2-4 counter sunk fasteners and the appropriate anchors. The corresponding sign or plaque is then fastened to the shim plate with very high bond double faced tape and silicone as required.

Very High Bond Tape Mounting, this method utilizes a neoprene tape product with high bond acrylic adhesive on both sides. This method is only recommended for application of signs to a nonporous surface.

6. Metal Access Door:

Location:

Where shown on the A-2 and A-3 series sheets.

Materials:

Formed steel door panel with flanges on four sides. Concealed hinge; door flange is a perforated taping bead with pre-punched holes.

20 gauge galvanized formed door panel, 26-gauge galvanized frame.
Formed door panel with multiple bends for added strength, flanged on four sides,
Integral perforated taping bead adds rigidity.
Concealed Hinges
Provide for cylinder lock & key, matching to the building lock system

5 stage iron phosphate preparation with white baked-on polyester powder coat on door panel and trim.

Size:

36 inches by 36 inches.

Model:

Subject to compliance with requirements and available sizes, manufacturers offering products that may be incorporated in the work include, but are not limited to the following:

Acudor DW-5040 (Basis of Design).
BabcockDavis
Milcor

7. Marker Boards and Tack Boards

Locations:

Refer to Sheets A-xxxx.

Size:

Sizes noted on drawings. Mount tray at bottom of all units at 2'-10" a.f.f.

Manufacturer:

Aarco Products, Inc.
Best Rite,
Claridge Carolina Chalkboard (Basis-of-Design)
Lemco,
Marsh
or equivalent product meeting the specifications below.

Materials:

Marker boards to be "LCS 24-217-M-24 gauge porcelain steel marker board as manufactured by Claridge; Series 200 trim with chalk tray with end closures. Color: white.

Tack Boards to be "Fabricork" #1380 EW as manufactured by Claridge, Series 200 trim. Color to be selected from manufacturer's full range.

8. Expansion Joint Covers

Locations:

Refer to 1/8-inch scale floor plans, plan details and roof plans.

Materials:

Expansion Joint Cover for 1-inch joints in masonry (interior and exterior).

Description: Impregnated compressible foam block.

Model: Construction Specialties VF-100.

Expansion Joint Cover for 1-inch joints in interior gypsum board.

Description: Extruded clear anodized aluminum and duroflex gaskets (where cover plates contact adjacent surfaces).

Model: Construction Specialties ASM -100 or 200 (as required by joint width) or equivalent.

For masonry surfaces, provide Construction Specialties GSM models or equivalent.

9. Entrance Floor Mats and Frames

Locations:

Refer to A-2 Series Drawings. Set units no closer than 6 inches away from masonry or storefront.

Materials

Stainless steel - Type 316 stainless steel for surface wires and support bars.

Floor Grids

Model and Description - G6 GridLine- Cradle 2 Cradle Silver certified, shall be manufactured from type 304 stainless steel in 1 1/8" (28.57mm), 5/8" (15.97), or 3/8" (9.52mm) depth (Select one, delete others). Wires to be .090" (2.28mm) x.150" (3.81mm) electronically welded and spaced .145 (3.68mm) apart. Unit must withstand 1000 lb./ wheel loads (load applied to a solid 5" x 2" wide polyurethane wheel, 1000 passes without damage).

Slip resistance in accordance with ASTM D-2047-96, Coefficient of Friction, minimum 0.60 for accessible routes.

Grid Frames

SSA - Stainless Steel Angle Frame shall be 1 ¼" (3.81mm) deep recess in Type 316 stainless steel with 1/8" (3.2mm) exposed surface.

Lock Down Mechanism

SL - Surface Lock Down shall be a solid, surface mounted device to secure the Gridline to the concrete surface. Made from Type 304 stainless steel

Available Manufacturers:

Construction Specialties, 3 Werner Way, Lebanon NJ 08833 USA 800-233-8493. email: cet@c-sgroup.com (Basis-of-Design.

Subject to compliance with Basis of Design requirements, ADA Compliance, and Slip Resistance, products from the following manufacturers will be acceptable:

Reese Enterprises, Inc.
Pawling Corp.
J.L. Industries
Kadee Industries

10. Dock Bumpers

Location and Size:

Refer to A-5 Series Drawings.

Manufacturer:

Durable Corporation, Norwalk, OH. or equivalent product meeting the requirements by:

Vestil Manufacturing Corp., Angola, IN.
Porter Industrial Supply, Tumwater, WA.

Molded Dock Bumpers; Molded rubber reinforced with nylon and polyester; minimum durometer reading of 80 plus or minus 5; tensile strength of 950 to 1050 psi (6550 to 7420 kPa). One-year warranty.

i. Profile: Model T; 3 inches (76 mm) thick from wall by 22 inches (559 mm) high by 22 inches (559 mm) wide.

Install per manufacturer instructions.

11. Folding Partitions

Locations:

Refer to drawings 1/A-4.11 B and 2/A-4.12.

Size:

Refer to drawings 1/A-4.11 B and 2/A-4.12, and 17,19/A-6.41

Manufacturers:

Subject to compliance with requirements and available sizes, manufacturers offering products that may be incorporated in the work include, but are not limited to the following:

Kwik-Wall (3030 - Straight Line, Center Stack, Paired Panels are Basis-of-Design)
Modernfold
Moderco

Materials:

Top supported Kwik-Wall Hufcor Series 3000 single panels or equivalent.

1. Panels shall be nominally 4” thick, to 48” maximum, in width, and hinged in pairs.
2. Panel faces shall be vinyl, laminated to steel substrate to meet minimum STC 51.
3. Frames shall be of 16-gauge painted steel with integral factory applied aluminum vertical edge and face protection.
4. Vertical sound seals shall be of tongue and groove configuration, ensure panel-to-panel alignment and prevent sound leaks between panels.
5. Horizontal top seals shall be standard, fixed vinyl; continuous contact.
6. Horizontal automatic bottom seals shall be retractable, provide up to 2” nominal operating clearance, and exert downward force when fully extended.
7. Horizontal trim shall be of aluminum.
8. Low profile hinges on basic panels shall be of steel and project no more than 1/4” beyond panel faces.

Finishes

1. Finishes shall be as selected by the Architect from manufacturer’s full range for:

   a. Factory applied reinforced vinyl fabric with woven backing, weighing not less than 15 oz. per lineal yard.
   b. Exposed metal trim and seal color.

2. Aluminum track shall be Type 850, clear anodized.

Suspension system:

1. Track shall be of clear anodized architectural grade extruded aluminum alloy 6063-T6. Track design shall provide precise alignment at the trolley running surfaces and provide integral support for adjoining ceiling, soffit, or plenum sound barrier. Track shall be connected to the structural support by pairs of minimum 3/8” dia. threaded steel hanger rods. Guide rails and/or track sweep seals shall not be required.

   a. Each panel shall be supported by one 4-wheeled carrier. Wheels to be of hardened steel ball bearings encased with molded polymer tires.

Other Requirements:

1. Provide a 3-foot-wide passage door in each wall, where shown on the drawings.

2. Applied markerboard panels from 32-inchas a.f.f. to 72-inches a.f.f.

12. Suspended Curtain Track (at Touch Tank)

Location:

Refer to drawing 1/A-3.22 B and 3/A-8-11.

Size:

As shown on the drawings. Field measure.

Manufacturers:

Subject to compliance with requirements and available sizes, manufacturers offering products that may be incorporated in the work include, but are not limited to the following:

Automatic Devices Company, Model 132-A, (Basis-of-Design)
2121 South 12th Street,
Allentown, PA 18103
Phone: 610.797.6000

QSD Inc.
6886 South Pitkin Street,
Foxfield, Colorado 80016 USA
Phone: 800.661.5649

Materials:

Provide all components required for a complete installation.

Curtain tracks (Model 1300) shall be of 13 gauge extruded aluminum I-Beam construction consisting of a center rib and top, intermediate and bottom flanges. Each curtain carrier **(Model 1301-A)** shall be spaced on 12" centers and shall be supported from two self-lubricating nylon wheels rolling on two parallel treads. Track shall be rigidly supported from ceiling clamps **(Model 1423)** or hanging clamps **(Model 1308)**. This model track system is for walk-along operation only and does not include pulleys or other operating hardware. 1-1/4" I.D. stiffening pipe or the equivalent shall be used to support both straight and curved areas of all suspended curved tracks.

Finishes

1. All metal components shall be Type 850, clear anodized or stainless steel.

Suspension system:

1. Install the 1308 hanging clamps or 1423 ceiling clamps with manufacturers standard hardware which shall be provided with the system components. Space supports no more than 4-feet on center. Clamps shall also be provided and installed on each side of each track splice or each curve and along the curve of the track if the curve radius is large.

2. Lift the track to its desired location and secure with appropriate hardware and suspension media as needed.

13. Composite Manhole Covers for Life Support System Viewing

Location:

Refer to A-2.22B.

Size:

36” Diameter Clear Opening.

Manufacturer:

EJCO 1006 Investment Blvd., PO Box 186, Apex, NC 27502
or equivalent product meeting the requirements by:

Fibrelite, 3250 US Highway 70 Business West,
Smithfield, North Carolina, NC 27577

Composite Access Products, LP, 5216 N 26th St., McAllen, TX. 78504

Basis-of-Design:

EJCO Model 3800, 5" Tall Composite Gasketed Manhole Assembly, 4 Penta Head Latches, 2 Spring Loaded Handles, Non-Traffic, Medium Duty.

Install per manufacturer instructions.

14. Coiled Wire Fabric Curtain System

Location:

Refer to 1/A-2.22 A and 1/A-3.22 A.

Size:

As shown on the drawings. Field measure.

Manufacturer:

Cascade Architectural, P.O. Box 3707, Tualatin, OR 97062

or equivalent product meeting the requirements by:

GKD GROUP, 825 Chesapeake Drive, Cambridge, MD 21613

Basis-of-Design:

Fabricoil® coiled wire fabric architectural system. Aluminum 5056 – H18 Wire Fabric created by interlocking individual strands of spiraled wire. 3/8-inch weave size, wire gauge as recommended by the manufacturer.

Track: Glide Track System - Manual Operation

Install per manufacturer instructions.

PART 3 - EXECUTION:

Install each item according to manufacturer's printed instructions and/or shop drawings. When complete, each item shall be complete with all accessories for complete operation and free of defects and in first class working condition.

END OF SECTION 100000

SECTION 111600 – HOIST + CRANE EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Electric Telescoping Hoists and Trolleys.

1.2 DEFINITIONS

A. Lifting, Telescoping Monorail: A lifting telescopic monorail is a device made up of two overlapped monorails. The first one is usually anchored under a concrete slab or under an existing steel structure. The second one can be moved by translation on driving manual, electric or air trolleys.

B. Working Range: Amount of travel required for each monorail, including telescoping element on Crane 1. The amount of vertical hoist distance required for each hoist.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For hoist and crane equipment. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Hoists and Cranes are considered unitary systems for which the manufacturer will be responsible to engineer the complete operation and provide any required engineering seals and certificates which shall be valid and recognized by the state of North Carolina.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product test reports.

C. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3, "Structural Welding Code - Sheet Steel."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Preinstallation Conference: Conduct conference at Project site.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of construction contiguous with hoist and beam equipment, including height above floor(s) and tanks and location relative to doors, by field measurements before fabrication.

1.8 WARRANTY

A. Special Warranty for Hoists: Manufacturer's standard form in which manufacturer agrees to repair or replace dock-leveler components that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including cracked or broken structural support members, load-bearing welds.
b. Faulty operation of operators, control system, or hardware.

2. Warranty Period for Structural Assembly: Ten years from date of Acceptance by Owner.
3. Warranty Period for Electric Motor: Five years from date of Acceptance by Owner.
4. Warranty shall be for unlimited usage of hoist and crane for the specified rated capacity over the term of the warranty.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM 316/A 316M.

B. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

2.2 HOIST AND CRANE 1

A. General: 2-ton capacity hoist and crane, telescoping, with large height heavy-duty marine environment chain hoist; of type, function, operation, capacity, size, and construction indicated; and complete with controls, safety devices, and accessories required, including swiveling hoist.

1. Basis-of-Design Product: Subject to compliance with requirements, provide products by ADEI, Meyzieu, France or comparable product by one of the following:

a. CMCO (Columbus McKinnon)

b. Washington Crane.
c. AFE Crane.

B. Rated Capacity: Capable of supporting total gross load of two tons without permanent deflection or distortion.

C. Mechanical Operating System: Manual control; counterbalance and spring operation. Spring-operated raising and walk-down lowering of unloaded ramp. Equip leveler with an upward-biased-spring counterbalancing mechanism controlled by a hold-down device. Ramp raises to top limit of operating range by operating recessed control handle in ramp to disengage hold-down device. Ramp lowers below platform level with lip retracted by operating auxiliary, recessed control handle to release support legs.

1. Free-Fall Protection: Manufacturer's standard protection system to limit free fall of loaded ramps with front edge supported by truck bed.

D. Electric Operating System: Electric control shall be radio-operated.

E. Construction:

1. Fabricate all rails from Type 316 Stainless Steel.

2. Fabricate electric steering trolly, chain, hook and roller from Type 316 Stainless Steel

F. Power supply:

1. Assure coordination of main voltage and travelling speed.

G. Finish: Hot-dip galvanize all non-stainless-steel components.

2.3 HOIST AND CRANE 2

A. General: 1.5-ton capacity hoist and crane, with heavy-duty marine environment chain hoist; of type, function, operation, capacity, size, and construction indicated; and complete with controls, safety devices, and accessories required.

1. Basis-of-Design Product: Subject to compliance with requirements, provide products by ADEI, Meyzieu, France or comparable product by one of the following:

a. CMCO (Columbus McKinnon)
b. Washington Crane.

B. Rated Capacity: Capable of supporting total gross load of one and a half tons without permanent deflection or distortion.

C. Mechanical Operating System: Manual control; counterbalance and spring operation. Spring-operated raising and walk-down lowering of unloaded ramp. Equip leveler with an upward-biased-spring counterbalancing mechanism controlled by a hold-down device. Ramp raises to top limit of operating range by operating recessed control handle in ramp to disengage hold-down device. Ramp lowers below platform level with lip retracted by operating auxiliary, recessed control handle to release support legs.

1. Free-Fall Protection: Manufacturer's standard protection system to limit free fall of loaded ramps with front edge supported by truck bed.

D. Electric Operating System: Electric control shall be radio-operated.

E. Construction:

1. Fabricate all rails from Type 316 Stainless Steel.

2. Fabricate electric steering trolly, chain, hook and roller from Type 316 Stainless Steel

F. Power supply:

1. Assure coordination of main voltage and travelling speed.

G. Finish: Hot-dip galvanize all non-stainless-steel components.

2.4 STEEL FINISHES

A. Galvanizing: Hot-dip galvanize components as indicated to comply with the following:

1. ASTM A 123/A 123M for iron and steel loading dock equipment.
2. ASTM A 153/A 153M or ASTM F 2329 for iron and steel hardware for loading dock equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine roughing-in for electrical systems for hoist equipment to verify actual locations of connections before equipment installation.

B. Examine structure for suitable conditions where equipment is to be installed. Structure shall be plumb and square and clean to receive integral hoist beam attachments.

C. Place hoist beams straight and level, centered on the pre-set equipment and doors..

D. Install equipment, including motors, control stations, wiring, safety devices and accessories as required for a complete installation.

1. Rough-in electrical connections.

E. Adjust equipment to function smoothly and safely, and lubricate as recommended by manufacturer.

F. Test lifts and motors for vertical travel within operating range indicated.

3.2 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain loading dock equipment.

END OF SECTION 111600

SECTION 111795 - LIFT FLOOR

PART 1 - GENERAL

1.01 USAGE

A. The lift floor shall be a free-standing device, not requiring special connections to the building/pool's structural elements, powered by the facility water pressure, and all exposed materials shall be non-corrosive.

1.02 SUMMARY

A. Work includes furnishing and installing a lift floor in the Isolation Pool of the shark exhibit including all appurtenances indicated on the drawings and/or specified herein. The contractor shall be responsible for providing a fully functioning device to the satisfaction of the Owner. The General Conditions apply to this Section as fully as if repeated herein.

B. Final Geometry: The contractor shall be responsible for both design and fabrication of the product to match the geometry and detailing indicated on the Drawings and as-build dimensions of concrete structures. Any adjustments required for field fit shall be made in the final size of the lift floor elements without modification to completed building or pool structural elements.

C. Reference Drawings: At the minimum, the bidding fabricators will require copies of drawing 5/A-4.13 together with this specification Section.

1.03 QUALITY ASSURANCE

A. Manufacturer's Qualifications: The tank fabricator shall have at least five years' experience in the manufacture of similar items with a record of successful installations at saltwater aquatic animal facilities.

B. Design Requirements: Design shall comply with these Specifications and all OSHA and local safety codes. Use conservative safety factors in the design of all products. Working stresses shall not exceed the lower value of one-third of the yield strength or one-fifth of the ultimate strength of the material.

1.04 SUBMITTAL

A. Submit fully detailed shop drawings of all fabrication work, giving sizes; details of fabrication and construction; methods of assembly; and locations of hardware, anchors, and all accessories.

B. Submit manufacturer's information on major materials or list product references on shop drawings.

C. Submit copy of binding warranty.

D. After fabrication of vessels, but before shipment, submit a manufacturer's certified Final Inspection Report addressing hardness testing of shop fabricated fiberglass resins (does not include manufactured pultruded FRP), finish workmanship, operation of movable elements, and other quality control aspects.

1.05 WARRANTY

A. Manufacturer shall warranty all individual components, and the functionality of the total lift floor system, to be free from defects in manufacturing, workmanship or materials, and

shall repair or replace any fabrication within one (1) year after field setup and calibration and Acceptance by the Owner.

PART 2 - PRODUCTS

2.01 LIFT FLOOR STRUCTURE

A. General: The movable floor shall have a capacity of 4,000 lbs and of dimensions shown on the drawings and verified by field measurements of completed concrete structures. The movable shall be a horizontal, free-standing, cylindrical structure. All materials shall consist of Type 316 or 316L stainless steel, fiberglass reinforced plastic (FRP), PVC plastic, and polyethylene (PE) plastic.

B. Lockout: The product shall include mechanical lockouts for safely diving underneath the movable lift floor.

C. Thickness: The movable lift floor shall not exceed a thickness of 11-inches; however, a lesser thickness is desired if possible. Any supports or other materials required below the movable lift floor shall not exceed 3-inch. The total finished dimension from the bottom of the Isolation pool to the top surface of the movable lift floor shall not exceed 12-inches.

D. Access Hatch: The movable lift floor shall include a hatch to allow access to below the floor when in the raised position.

E. Cylinder Location: The structural design of the movable lift floor, and selected structural elements, shall be such to move the lift cylinders to the extreme corners of the assembly and not intrude into the open area of the Isolation pool. Exact shape of lift platform and location of cylinders to be approved by owners.

2.02 LIFT CYLINDERS

A. Lift cylinders shall have upper sleeves attached to the movable floor with hydraulically actuated stanchions pushing down against the concrete floor of the Isolation pool. One cylinder shall be located in the four corners of the movable lift floor. The bore of each cylinder shall be approximately 8-inch diameter.

B. The lift cylinders shall fully raise the movable lift floor in approximately 60 seconds using 60 psi water pressure.

2.03 LIFT FLOOR FABRICATOR

A. Products meeting the requirements of this specification may include:

Truelove Fabrications Inc.
13 S. 4th St.
Wilmington, NC
910-612-6555

Strongwell; Bristol, Virginia

Aqua-Draulics Marine, Inc
4035 Pines Industrial Ave
Rockledge, FL 32955

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install lift floor per manufacturer's recommendations.

B. The lift floor shall be aligned, calibrated as required, and proven fully functioning by the installing contractor.

END OF SECTION 111795

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SECTION 11 59 01

GENERAL EXHIBIT REQUIREMENTS

PART 1 - SUMMARY OF WORK

1.01 GENERAL SCOPE OF WORK

A. The work under the exhibit scope of work consists of the fabrication and installation of exhibit work to be performed as part of the General Contract Work and completed by the time of final completion of General Contract Work.

1.02 DRAWINGS FOR EXHIBIT FABRICATION

A. The Exhibit drawings are those designated with the prefix of "EX," which are bound separately from these specifications and are hereby made a part of the Contract Documents for the Exhibit scope of work.

B. All drawings issued in addition to those designated with an "EX" prefix are considered part of the Contract Documents, as instructed by the Construction Manager for the project.

1.03 SPECIFICATIONS FOR EXHIBIT FABRICATION

A. The specifications for exhibit fabrication consist of the following sections:

Division 11 59 00– Exhibit Fabrication

11 59 01 General Exhibit Requirements

11 59 10 Fiberglass Exhibit Tanks (also refer to section 06 60 50 for all engineering, resins, attachments, acrylic, etc.)

11 59 20 Replicated Habitats (Design Development Level Only)

11 59 30 Interpretive Graphics

11 59 40 Media Software

11 59 50 Media Hardware

11 59 70 Exhibit Furniture & Casework

1.04 RELATED WORK BY GENERAL CONTRACT

A. The following related work will be performed by the General Contractor and their designated sub-contractors, and as such is related to, but not part of the exhibit fabricator's work. Construction, furnishing and installation of, but not limited to, the following:

1. Site preparation, grading, driveways, parking areas, walkways related to gaining access to the site

2. Base-building architectural construction inclusive of all built-in-place concrete tank structures.

3. Base-building and site mechanical, electrical, lighting, plumbing, phone, public address, and life safety systems.

4. The Owner will provide 5 existing jellyfish tanks of various shapes and sizes for inclusion in the project.

5. Supply and installation of all architectural finishes including painted walls, flooring, ceiling treatments, trim details, doors, windows, information desk, and acoustic wall and/or ceiling treatments unless otherwise stated within the contract documents.

B. The General Contractor shall be the general coordinator of interfaces between all work and the work of this Contract. "Interface" is defined to include the scheduling and sequencing of work, sharing of access to work spaces, integration of work placed into spaces available for installation, protection of each other's work, cutting and patching, cleaning, utilization of temporary facilities and similar considerations and activities. The General Contractor shall set up coordination meetings to be attended by all parties involved.

1.05 INSPECTION

A. Carefully inspect all surfaces and conditions, which receive the work of the Contract and notify the General Contractor of any defects, improper materials, workmanship or other conditions, which will affect the satisfactory completion, and permanency of the work. The absence of such notification will be construed as an acceptance by the Exhibit Contractor of all surfaces and conditions, and as a waiver of any subsequent claim to the contrary.

1.06 FIELD MEASUREMENTS

A. The Exhibit Contractor shall perform all work of the Contract from shop drawings or field measurements taken by the Exhibit Contractor at the project site and/or at the of the shop other Contractors as required.

B. Any discrepancies between the field measurements and the shop drawings that affect the fabrication or installation of the work of the Contract shall be reported to the General Contractor, in writing, prior to fabrication or installation of any affected work.

1.07 INSPECTION OF FABRICATED WORK

A. Prior to delivery of fabricated items to the site, complete work shall be inspected by the General Contractor, the Owner, and/or the Exhibit Designer at the place of fabrication.

B. The Exhibit Contractor shall notify the General Contractor when and where such work will be available for inspection. Fabricated work shall not be delivered to the site until approved by the General Contractor at the place of fabrication or authorization to deliver such work to the site is granted for subsequent inspection at the site.

1.08 APPROVAL OF COMPONENTS

A. Where components are indicated to be provided by the Exhibit Contractor but are not mentioned by manufacturer's product name or model number, the construction of all such items shall be subject to approval by the General Contractor and shall conform to approved corresponding submittals, samples, and mock-ups. The Exhibit Designer may submit additional drawings to the Exhibit Contractor for elaboration, clarification or revision of such items at the discretion of the General Contractor. The Exhibit Contractor's work shall conform to such additional drawings without additional cost to the Contract, unless prior written authorization for additional cost items has been properly secured through the General Contractor.

1.09 PROTECTION

A. Adequately protect all work contained within this contract against damage and repair and/or replace all defective or damaged work as directed by the General Contractor as required to leave the work in a condition satisfactory to the General Contractor at the time of completion of the Contract.

B. Protect and be responsible for any disturbance or damage to adjacent construction within the area of operations under this Contract. Any disturbance or damage to the adjacent construction either directly or indirectly from the operations of this Contract shall be promptly restored, repaired, or replaced to the satisfaction of the General Contractor and at no additional cost to the owner.

C. With regards to any work that requires ventilation of fumes and/or dust, coordinate needs and requirements with the General Contractor so that proper systems are in place. Do not assume that a system will be provided for your scope of work, unless otherwise clearly stated by the General Contractor prior to the time of submitting final proposals for the work. Under no circumstances will the requirements for ventilation of fumes be just grounds for closing the facility to the public.

1.10 DELIVERY

A. All deliveries of materials, equipment, and pre-fabricated exhibit elements must be coordinated with the General Contractor.

B. All uses of public areas and circulation pathways must be coordinated with the General Contractor. All weights and sizes must conform to the limitations of these spaces.

PART 2 - SHOP DRAWINGS, PRODUCT DATA, SAMPLES, AND MOCK-UPS

2.01 PROVISIONS INCLUDED

A. The Contract Forms, Conditions of the Contract and Division 1, General Requirements, apply to the work of this Section and other relevant Sections.

2.02 DEFINITIONS

A. “Shop drawings” are fabrication, erection and setting drawings, diagrams, schedules, and other data, specifically prepared for the work under this Contract by the Contractor or any Subcontractor, manufacturer, supplier or distributor, to illustrate some portion of the work.

B. “Product Data” are catalogs, brochures, cuts; manufacturer’s specifications and installation instructions; performance and test data; diagrams and other information submitted by the Contractor to illustrate a material, product or system for some portion of the work.

C. “Samples” are physical examples submitted by the Contractor to illustrate materials, equipment or workmanship, and to establish standards by which the work will be judged.

D. “Mock-ups” are physical simulations of specific exhibit features to demonstrate the functionality of complex exhibit elements from which final design decisions and details maybe determined.

E. “Graphic proofs” are physical examples submitted by the Contractor to illustrate all actual graphic and typographical artwork.

2.03 PRODUCT DATA

A. Product data shall be specific, with all extraneous material deleted and only the information directly pertaining to the project check-marked or boxed. Furnish all supplemental information as may be requested. Data of general nature will not be accepted.

B. Due to the nature of this project and the work of all involved, sustainable design is an important quality that should be maximized wherever possible and affordable. All Exhibit Contractors are expected to provide statements that summarize the extent to which they are able to comply with such standards. Sources, materials, methods of construction, power requirements, etc. that support sustainable practices should all be identified as part of the scope of this work.

2.04 SAMPLES

A. Samples shall be of adequate size to permit proper evaluation of function, physical and visual characteristics of product, material or intended “artistic” treatment required for aspects of the exhibit scope(s) such as: graphics; media hardware systems; media software systems; interpretive and interactive exhibitry; costume millwork, replicated artifacts or artwork etc. Samples must successfully show color, texture, form, durability, and any other feature(s) specified by these specifications, the Owner, and the General Contractor.

2.05 MOCK-UPS

A. Mock-ups (where specified) shall be full size (unless otherwise specified) so as to allow for proper evaluation of the final work. Mock-ups must successfully show the shape, actual materials whenever practical, and the overall color and character of each element as seen within the location where the element is to be installed.

2.06 GRAPHIC PROOFS

A. Proofs shall be made at the appropriate size for each graphic element sufficient for the Exhibit Designer’s review of the proof.

2.07 SUBMISSION OF FULL SIZE PROTOTYPES AND MOCK-UPS

A. All prototypes and mock-ups, especially those not appropriate for shipping, shall be held by the Contractor and will be reviewed by the Owner, General Contractor, Architect and Exhibit Designer at the Contractor’s shop.

B. Refer to the individual specification sections for more specific requirements regarding prototype and mock-up requirements.

END OF SECTION

SECTION 11 59 10

FIBERGLASS EXHIBIT TANKS

PART 1 - GENERAL REQUIREMENTS

1.01 PROVISIONS INCLUDED

A. The Contract Forms, Conditions of the Contract and General Requirements, apply to the Work under this Section.

B. Related sections include:

1. Section 06 60 50 - Fiberglass Tanks
2. Section 08 84 00 - Acrylic Glazing
3. Division 17 – Piping Connections

1.02 SCOPE OF WORK

A. The Work under this Section consists of fabrication, delivery and installation supervision of all fiberglass (FRP) tanks, the acrylic viewing panels for the tanks, and tank bases as indicated on the drawings and as specified herein.

#	Exhibit Name
E-3	Live Coral
E-4	Aquaculture
E-5	Piaba
EX-1	Cuttlefish
EX-2	Spiny Lumpsucker
EX-3	Pacific Rocky Coast
EX-4	Weedy Sea Dragon
H1	Touch Tank Knock-Down
H2	Touch Tank Recovery
H4	Coral Growing
H5	Coral Growing

B. The Work under this Section also consists of the coordination and installation all acrylic viewing panels for these FRP tanks, as well as tank stands and in-tank filter plates (as indicated by drawings).

C. Requirements of this Section are in addition to those specified in Section 06 60 50 – Fiberglass Reinforced Tanks and Section 08 84 00 – Exhibit Tank Glazing, both of which apply to the Work of this Section.

1.03 WORK BY OTHER CONTRACTORS

A. The connection with all Life Support System plumbing, as well as any under-gravel distribution piping will be by the designated LSS Contractor, but all tank penetrations will be integral to the fabricated FRP tank and provided as such.

B. Habitat gravel substrate.

C. All adjacent wall, floor, and ceiling construction and related adjacent surfaces and equipment.

1.04 WRITTEN INFORMATION

A. Quality Control Design Calculations Submittals: All materials of fabrications as shown are schematic and require calculations by FRP Manufacturer/Fabricator; include design loading, structural computations, materials properties, resin formulations and other information needed and used for structural analysis.

B. Product List: List of products to be used in fabrication of FRP tanks. For information only, submit copies of manufacture's detailed technical data and specifications for materials, fabrication, joinery, and installation. Include catalog cuts of hardware, anchors, fastenings and accessories.

1.05 REFERENCE STANDARDS

A. Conform to the requirements of Voluntary Product Standards PS 15-69 "Custom Contract Molded Reinforced Polyester Chemical Resistant Process Equipment" as a minimum standard, except where superseded by more stringent of the specifications.

1.06 SAMPLES

A. Cured sample sections (12"x 12") of each color Gel Coat demonstrating lamination, colors and surface finishes.

B. Acrylic viewing window per the requirements specified by Section 08 84 00 Exhibit Tank Glazing.

C. Sample of sealing and joint assembly proposed for use, indicating color and finish and specification, as well as demonstrating any visible seams that might be required.

D. Sample of full assembly of all elements inclusive of FRP, acrylic and gel coat.

1.07 SHOP DRAWINGS

A. Submit shop drawings for each tank showing the following:

1. Plan, elevation, section views

2. Glazing and tank-related life support system details (penetrations, skimmer boxes, stand pipes, etc.)

3. Wall sections showing lamination details and thickness for inner and outer skins, core material, and reinforcing details at windows and pipe penetrations.

4. Acrylic windows (see specification section for acrylic windows for aquarium tanks).

5. Background color confirmed

1.08 QUALIFICATIONS

A. The fiberglass tank Contractor shall submit at time of Bid Proposal a list of five installations of fiberglass aquarium tanks which have been successfully in place for at least five years and which are similar in construction to those shown on the drawings. At the same time submit tank lay-up methods.

B. Acceptance of the Proposal will be dependent upon review and acceptance by the Owner of the proposal construction techniques.

1.9 QUALITY CONTROL

A. All fiberglass tanks will require the Exhibit Contractor to submit engineering calculation in accordance with Section 06 60 50 – Fiberglass Tanks.

B. Quality craftsmanship - All fiberglass fabrication shall conform to this Section as to materials, drawings and dimensions. All Gel-Coat surfaces shall be solid, smooth and uniformly colored without streaks or blotching. All hand lay-up work shall be smooth to the touch, with all glass fibers and roving completely embedded in resin. Exposed glass fibers and/or edges will be grounds for rejection.

C. Allowable Tolerance:

1. The relationship of the various components shall be such that they prohibit the escape or entrapment of animals contained.

2. Variations in the lines and surfaces of floors: 1/4" per 10 ft.

3. Variations of viewing window head and sill rebates receiving glazing: 1/8" per 10 ft.

4. Variations of sizes and locations of sleeves, floor openings and wall openings: Minus 1/8", Plus 1/8".

5. Flexure at head, jamb and sill of windows shall not exceed 1/8" when filled. Flexure elsewhere shall not exceed L/360 of the measured span.

1.10 COORDINATION

A. The fabrication of fiberglass tanks shall be accomplished in such a manner as to coordinate with other elements such as floors, walls, plumbing, as well as internal habitats.

1.11 DELIVERY, STORAGE AND HANDLING

A. Storage and handling of completed fiberglass tanks at the FRP Manufacturer/ Fabricator's shop shall be accomplished in such a manner as to assure that all components are in new and undamaged condition. All materials are to be stored under cover in a well-ventilated enclosure and protected against extreme changes in temperature.

B. Each tank will be tagged with the manufacturer's drawing and tank number and location plan for ease of identification.

C. Do not deliver materials to the site until notified by the Owner.

D. Scheduling and final placement will be the responsibility of the Building Contractor.

PART 2 - PRODUCTS

2.01 FIBERGLASS TANKS

A. Fiberglass tanks, including exterior and/or internal skimmer, shall be of completely integral construction as shown on the drawings. Interior surfaces shall be smooth and free of projections.

B. Fiberglass tank wall thicknesses to be determined per the specifications found in Section 06 60 50.

C. Integral color shall be impregnated on the interior surfaces only and shall be provided only on those tanks designated to receive color as noted on the drawing.

D. Tank acrylic shall conform to the requirements set forth in Acrylic Tank Glazing specification and in general:

1. The acrylic materials and performance of these materials are considered part of this scope.

2. The installation of the acrylic into the window rebate of the FRP tank is considered part of this scope.

3. All liabilities associated with the acrylic and its interface with the FRP tank materials and construction are the sole responsibility of the FRP Tank Contractor

E. Spacers to be placed around glazing material as determined by FRP Manufacturer. Base shims shall be placed as determined by FRP Manufacturer at quarter points as shown on the drawings.

F. Sub-gravel filter plates are not required for this project

G. Air lift pipes, pipe fittings to be PVC pipe of sizes shown on the drawings.

I. Acrylic joint adhesive shall be clear and bubble-free, equal to PS30 or Weld-On 40.

PART 3 - EXECUTION

3.01 INSPECTION

A. Verify that areas to receive fiberglass tanks are satisfactory to receive tanks. If unsatisfactory conditions exist, do not ship until such conditions have been corrected.

B. Confirm route of delivery from loading dock to final installation location to assure that the route provides sufficient clearances for the tank and any rigging materials that might be required during delivery

3.02 FABRICATION

A. Fiberglass tanks shall be as follows:

1. To be molded over a “male” type mold to obtain a smooth interior finish.

2. All interior surfaces to be of a matte, Gel Coat finish 18-20 mil. in thickness. No visible surface flaws. Colors to match chips provided by Owner will be by Ferro Corporation, Neste Polyester, Inc. or equal.

3. Vertical tank walls to be of a sandwich-type, composite construction with rigid foam core of 1.5” to 2” thickness as required for structure and insulation.

4. First lamination to be hand applied and of a sufficient number of layers of chopped strand mat and woven roving to acquire a minimum of 1/6th of the engineered wall thickness. Both lamination and core material are to be of an appropriate thickness for the tank size/gallonage.

5. A 4-6 lb. per cubic foot core material is to be applied to the first laminate, to gain the thickness engineered for core construction methods.

8. No voids between core and first lamination.

9. A second, outer lamination is to be of the same thickness and quality as the first.

10. The outside finish is to be reasonably smooth and free of exposed fibers, and of an easily cleaned, white polyester finish.

11. No raw fiberglass is to be present in any surface.

12. All window rebates/ledges are to be molded into the tank, and be designed so that the mounted viewing panels, whether glass or acrylic, be flush to the interior surface of the tank.

13. All fittings are to be FRP type and flush with the interior tank surface.

B. Tank reinforcement

1. Window area and wall reinforcing will be used as required by the FRP Manufacturer/Fabricator. Secondary FRP bond to be of equal thickness as reinforcing material and have a minimum of 3" of bonding surface beyond all sides of the reinforcing material.

2. Flanges: Flanges maybe required and will only be allowed with supporting engineering documentation and approval by the General Contractor, Architect, Owner, and Exhibit Designer. Flanges for tanks smaller than 100 gallons to have flanges no greater than 3" and no greater than 6" for tanks in excess of 100 gallongs. Flange thickness is to be determined by the FRP Manufacturer and confirmed with engineering documentation, with no variation in thickness greater than 1/8". Flanges in sides and back of tank are to be outboard. Front flanges maybe outboard provided they do not exceed 3" regardless of the tank volume. Flanges are to be continuous around the tank opening at the top.

3, Lateral bracing is only allowed for supporting long spans of fiberglass formations where specifically indicated on Exhibit Drawings. The engineering and detailing of such braces will be the responsibility of the Fiberglass Tank Contractor, and must be coordinated with the work of the Replicated Habitat Contractor to assure the habitat form(s) can be installed within the tank.

4. Confirm that reinforcement and flange details do not interfere with any adjacencies nor alter the intended design and appearance of the exhibit tanks

C. Weir opening and skimmer box: provide weir opening, as indicated on Exhibit Drawings, Weir to be of a symmetrical and finished nature. Skimmer box to have the same inside/outside finish requirements as tank and the same secondary bonding requirements as the tank reinforcement.

1. Note special design of skimmer boxes with perforated panels, as indicated for the Giant Pacific Octopus Exhibit #11, and consult with Exhibit Designer, Owner, and LSS system designer to assure proper function of the tank with the LSS system.

D. Shop-assemble all FRP Tanks in single units, except where indicated. Provide shop-prepared attachment devices for field connections where necessary. Design attachment devices so that field connections will comply with fastening and joinery construction requirements and tolerances for the specified grade.

3.03 PERFORMANCE

A. Hydro-test all tanks prior to shipping per Section 06 60 50 – Fiberglass Tanks.

B. Fill tanks with water and test water levels over 48 hours for leaks, etc. upon the completed delivery and installation of the tanks to the project site, the hook-up (by others) to the Life Support System, and prior to the installation of the Replicated Habitat Work (unless the Tank Contractor and the Habitat Contractor are one in the same in which case, the tank will be tested with the habitat in place)

C. Repair damaged or defective work as directed.

D. Clean exposed interior and exterior surfaces.

E. All tests to be observed, judged, and approved (or rejected) by the Owner and/or Exhibit Designer.

3.04 DELIVERY

A. Coordinate all logistics of delivery to site and into building with Construction Manager. All routing and clearances into final exhibit location to be confirmed prior to delivery.

B. Use qualified rigging personnel for all delivery tasks.

PART 4 - INSTALLATION

4.01 INSPECTION

A. The FRP Manufacturer/Fabricator will inspect the conditions under which the Work is to be performed and shall report in writing to the Owner any conditions which might adversely affect the installation. Installation shall not be started until conditions are satisfactory.

4.02 INSTALLATION

A. Installation shall be performed by a qualified rigger (approved by the Owner) and under the direction of the Tank Contractor and shall be performed prior to completion of the adjacent wall construction work.

B. Tanks shall be set by the Tank Contractor, and coordinated with the Construction Manager and at location as shown on the drawings and where directed by the Owner.

PART 5 - GUARANTEE

5.01 GUARANTEE

A. Fiberglass tanks and their related acrylic viewing panels (as a complete water-holding assembly) shall be guaranteed for a period of five years from time of delivery to be free of defects of either material or workmanship, and shall be appropriately constructed and engineered for the intended use.

END OF SECTION

SECTION 11 59 20

REPLICATED HABITATS

PART 1 - SUMMARY OF WORK

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 PROVISIONS INCLUDED

A. The Contractor is expected to be familiar with all other sections of the specifications and drawings as issued for Exhibits and will need to be familiar with specification and drawings as issued for Architecture and Engineering

B. Photographic reference photographs displaying color, form and texture of actual habitat features will be provided upon selection of contractor. Shapes, forms, colors and textures shown in the photographs are intended to supplement the drawings as a means to describe the desired geology and character of rockwork for this project. The drawings will take precedence over the photographs with respect to final layout, overall volumetric massing, dimensions, grade elevations, structural reinforcing and detailing. In no way should the photographic reference material create a change in scope of services, but instead should serve as a means to describe particular color and textures.

1.03 SCOPE OF WORK

A. The work under this Section consists of the furnishing and installing of replicated, naturalistic, habitat features as indicated by the Drawings and Reference Photos and Specifications.

B. Given the unique nature of this work, it is understood that prospective Contractors may vary in their approach to materials, fabrication and installation. These specifications therefore include a variety of materials, processes, and installation requirements that may not be applicable to the final materials and methods determined for this project. It will be the responsibility of each prospective Contractor to review all specifications related to this work and determine and inform all parties of their recommended approach to this work. In doing so, confirm the applicable materials, processes and installation techniques, as part of the scope of this work

1. The habitat construction work shall include all materials, labor, equipment, and related services necessary to provide, furnish, install, and erect the exhibit including the following elements of exhibit construction:

E-1	Touchtank
E-2	Sand Tiger Shark
E-3	Live Coral
E-4	Aquaculture
E-5	Piaba
EX-1	Cuttlefish
EX-2	Spiny Lumpsucker
EX-3	Pacific Rocky Coast
EX-4	Weedy Sea Dragon

1.04 WORK BY OTHER CONTRACTORS

A. Formation of existing concrete tanks inclusive of initial construction, cutting, patching, waterproofing, painting, and glazing.

B. Life support systems inclusive of all in-tank piping features, plenums, filter mesh, etc. that are directly associated with those systems will be provided by the others.

C. Crushed coral, gravel, and rock rubble intended for any exhibit interior will be provided by the Owner.

D. Artificial kelp will be provided by owner.

D. Acid Leaching of Replicated Rockwork Formations will be performed by the Owner.

1.05 SUBMITTALS

A. Submittals will be required for this project. Unless otherwise stated by the Architect or General Contractor, the Contractor will provide the number of copies, as specified by the General Contractor, of each non-digital submittal (such as samples) will be required, and will include:

1. Shop drawings

2. Engineering calculations for all structural elements

3. Weight load calculations for all elements that come in contact with concrete and/or gunite pool structures, as well as confirmation of all attachment points made within aquarium tanks at locations below water.

4. Product data

5. Full size samples and/or mock-ups

6. Work-in-progress photographs and/or video recordings

7. Administrative Submittals

8. Quality Control Program

B. No Work shall be done except from issued Construction Drawings and related Contract Documents, including reviewed submittals, which must be kept at all work locations.

C. Review shall not act to relieve the Contractor from responsibility for accuracy of the fabrication details and placing diagrams. Dimensions and locations to be verified prior to the presentation of Shop Drawings.

D. Shop Drawings and Engineering Calculations:

1. Shop drawings and engineering calculations shall be submitted by the Contractor for review prior to the installation of habitat features described in the Construction Documents.

   a. Any Shop drawings required for reinforcement shall be prepared according to prevailing standards for hand-carved gunite, and/or pre-cast Glass Fiber Reinforced Concrete (GFRC) construction as appropriate.

2. Submit shop drawings of all construction joints, structural elements, attachment points, etc. for approval. Construction joints, structural elements, attachment points, etc. shall be designed and located by Contractor and approved prior to any work proceeding on site.

   a. Within 2 weeks of contract signing, the Contractor will issue a list of all anticipated shop drawings and engineering calculations that will be required based upon the requirements of these specifications and the Contractor's best judgment of the scope of work and any addition requirements that would call for shop drawings.

3. Submit plan diagrams of anticipated weight loads distributed over the footprint of the exhibit for review.

E. Product Data and Written Information

1. Submit proposed chemical and aggregate mix proportions. Include test data histories of proposed chemical mixes.

2. Submit reports for structural reinforcing (FRP, black bar, epoxy bar, etc.)

3. Submit data for proprietary materials and items, including admixtures, patching compounds, curing compounds, and others as requested.

F. Samples

1. The Contractor will be required to submit up to four sample panels of each type of habitat feature to be replicated as part of this project, indicating general character, shape, texture and durability required under this project. Panels shall be no smaller than 1'-6"' x 1'-6". Samples shall represent the finished surfaces, texture, coloring, etching, etc., as shown on the documents or as directed.

   a. Production samples (provided after the award of a contract, but before purchasing and/or fabrication of the final exhibit features) will be required for:

      1. Striated shale rock substrate
      2. Granite-like rock substrate
      3. Tacoma Narrows Bridge formations
      4. Each species of replicated aquatic plant
      5. Touch tank rock formations
      6. Gulf of California seamount substrate
      7. Each species of replicated enhancement coral and/or encrusting organism

   b. No habitat work shaping, fabrication, installation of hand-carved gunite or pre-cast GFRC panels, texture, or coloring of the final habitat Work formation shall begin prior to approval of samples.

   c. Samples shall not be removed from the project site until substantial completion.

   d. Rejected samples shall be resubmitted for approval at no additional cost to the Owner.

2. Furnish representative samples of materials for materials testing, mix proportion testing, and other forms of testing as may be required.

3. Specifically provide samples of materials that accurately represent the density and weight of materials that will be installed as part of this work.

4. Additional photographs displaying color, form and texture of actual landscape features to be replicated may be submitted by the Contractor at the Contractor's discretion, in order to more fully define the results of the Work. These photographs must be reviewed by the Owner (and the Owner's Design Team) and Owner's husbandry staff before any features indicated in the photographs are incorporated in the Work.

5. In the event that texture molds (for hand carved gunite or pre-cast GFRC formations) do not exist for the enhancement corals, rock substrate or other habitat feature described in the Drawings, submit a written summary along with colored photographs describing the process by which new molds are to be taken, or describe through samples or examples of comparable, previous work, methods for creating the appearance of the substrate in question.

G. Digital Progress Photographs and Video Documentation

1. All pre-fabrication (at the fabricator's shop) and on site fabrication/installation will be digitally photographed and/or video recorded for purposes of communicating with the Exhibit Designer as to the progress being made. Failure to comply may result in delayed processing of pay applications.

2. Digital files will be submitted no less than on a weekly basis as long as fabrication work is in progress, and once on site, progress will be submitted at least twice per week.

3. All submittals to be date encoded, unedited (or enhanced), and submitted via email to insure timeliness of the submittal and the subsequent review by the Design Team and the Owner.

H. Administrative Submittals

1. Description of planning, equipment, methods and quality control program.

2. Detailed construction schedule, coordinated with the general construction schedule per General Requirements.

3. Contractor qualifications, as noted below, will be submitted with the bid.

1.06 QUALITY ASSURANCE

A. Qualifications of Contractor:

1. To be considered qualified for this scope of work, it is recommended that the Habitat Contractor be a Commercial Member of the Association of Zoos and Aquariums (AZA), and shall provide evidence and supporting data for the following requirements.

a. Established firm with a minimum of ten (10) years experience in successfully constructing simulated natural rock formations for natural habitat exhibits of similar nature to the project. Established firm with a minimum of five (5) years experience in casting and/or hand laid-up sculpting of FRP and or GFRC rock panels.

b. The Contractor shall submit for review, full documentation of their construction crew, including superintendent and artist personnel, detailing the experience of each person listed, including visual portfolios showing key individuals' prior work, and their ability to perform all phases of the Work. The Owner's Representative reserves the right to request changes in the Contractor's personnel in order to obtain the highest level of talent available from that organization for this project. Submittal shall also detail physical facilities and established quality control procedures, and a management capability sufficient to produce the required units without causing delay of the project.

c. The Contractor shall submit a list of four (4) recent, completed installations of comparable nature. The list shall indicate the project name and location, project budget for the Contractor's portion of the Work, the Architect, and the name, address and phone number of the Exhibit Designer.

d. The Contractor shall submit photographic proof as references of their experience and ability to construct habitat, substrate, and enhancements similar to those shown on the drawings and photographic references. These materials shall be used to evaluate the Contractor's ability and experience to perform this Work.

e. The Contractor shall submit samples of their choosing that demonstrate their skill and experience with comparable habitat formations. These samples will not replace the need for formal submittals, as outlined in paragraph 1.05 – F of these specifications, but instead will serve as further evidence of the Contractor's qualifications for this project.

B. Direction Regarding Habitat Formation Work:

1. It is intended that the finished products of Work in this Section simulate replicated naturalistic habitats as shown in the Construction Drawings, and as specified herein.

2. To achieve these simulations, the Contractor will coordinate and cooperate fully with others as required and directed.

3. All Work in this Section shall be performed under the observation and review of the Owner's Representative

4. The Owner, Contracting Officer, Architect and Exhibit Designer explicitly reserve the right to continuously monitor the Work for aesthetic quality conforming to the Contract Documents.

C. Design Criteria Regarding Habitat Formation Work:

1. The fabrication of replicated habitat elements will be based upon the Construction Document drawings and specification, as well as the scale models that have been identified within these specifications. Note that the Exhibit Designer and Client will take active roles in finalizing the scale models, in part to assure that the massing and overall character of each replicated habitat has been studied and confirmed in model form prior to full-scale production, fabrication and installation occurs.

2. The fabrication of all habitat formation work, placement, installation, and/ or adjustment of enhancements and other finish details and exhibit accessories shall be accomplished in such a manner as to appear as realistic as possible and "read right" to the trained eye.

3. This project is artistic in nature and may require adjustments, reconstruction and or/ minor demolition of completed Work to obtain the desired effect. Minor changes or adjustments to in-place Work shall be made at no increase to the Contract Sum.

4. General plan contours of substrate, as shown, shall be followed to properly convey the desired artistic effect. Deviations from the general plan contours shall be made only upon approval.

5. Prior to applying hand-carved gunite or pre-cast GFRC panels over the top of any structural armature or plumbing element, the Contractor shall ensure that every possible precaution is taken regarding future potential for the escape of all animals (from the visible exhibit area to non-visible and hollow, back-side of exhibit Habitat Work panels) by verifying that all perforations, penetrations, crevices and animal enclosures satisfactory meet the containment requirements established. Such openings should be no greater than 1/2" in any direction, unless prevented otherwise.

6. Prior to applying hand-carved or pre-cast GFRC panels over the top of any fiber grate decking or piping that is part of the life support system, the Contractor shall ensure that every possible precaution is taken to maintain the water flow and in-tank control and access requirements established by the Owner (and the Owner's Design Team) and the Life Support Engineer.

7. The installation of Work related to this Section shall be performed by the Contractor provided they meet the criteria and requirements specified with Section 1.05 of this specification.

8. Due to the complex nature this project, the Habitat Contractor will be required to provide coordination documents that will assure that the work of this contract will be executed as intended and without any conflicts to adjacent work outside of the scope of this work.

9. Prior to commencement of any pre-fabrication or site fabrication work, the Contractor must be given an approval to commence with work based upon, but not limited to, the successful review of the anticipated weight loads of the work.

10. All fabricated rock formations within public reach must be clear of sharp, pointed protrusions.

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D. Habitat Formation Quality Control:

1. The Contractor shall have an established Quality Control program in effect prior to letting of the contract. A copy of this program shall be submitted for review.

2. Testing of materials and inspection of production techniques shall be the responsibility of the manufacturer and Contractor unless noted otherwise.

3. Routine testing services will be performed by an approved, certified testing agency. The designated testing agency will:

   a. Test the proposed materials, including water, for compliance with specifications.

   b. Review and check proposed mix proportions.

   c. Test pre-construction test specimens

   d. Secure production samples of materials at the Contractor's shop during construction and test for compliance with specifications.

   e. Continuously observe the placement of reinforcement and structural elements.

4. The Contractor will keep quality control records available for two years after final acceptance.

5. Testing Hand-carved Gunite or Pre-cast GFRC Panels:

   a. A quality control program shall be in effect to monitor glass content, concrete mixture, pigments, spray rate, product physical properties, and curing period and conditions. Results of such quality control tests and evaluation of such tests shall be available upon request.

   b. Preparation of the test specimens and test procedures shall be in accordance with industry standards for "Recommended Practice for Glass Fiber-Reinforced Plastic-Formed Panels", or " recommended practice for Glass Fiber-Reinforced Concrete-Formed Panels" especially as it relates to quality control.

1.07 STANDARDS

A. Comply with the provisions of the following codes, specifications and standards. However, in case of conflict, these specifications and drawings shall take precedence.

B. Plastic Resin Materials and Structures:

1. American Society for Testing and Materials (ASTM): The specifications and standards hereinafter referred to, latest edition.

C. Gunite Materials and Testing:

1. The Owner shall employ an independent testing agency to design concrete mixes and to perform material evaluation tests. Provide 7 and 28 days cylinder tests. Comply with ASTM C 143, ASTM C 173, ASTM C 31, and ASTM C 39.

D. All Work:

1. Standard criteria for performance of Contractor require that the following exhibit guidelines be adhered to: RTFD-F1; RTFS-F1; and NC/O-F1.

2. Standard criteria for performance of all parties require that the following exhibit guidelines be adhered to: LHSF-F1.

1.08 PROTECTION OF PROPERTY

A. In addition to normal precautions for the protection of the public, workers and property, take special precautions to prevent contamination of soil or water/sewage systems with cement, paint, dye, resins and other chemical materials.

B. Limit the area for working and storing chemical materials to areas within ten horizontal feet of exhibit structures and other areas specifically approved.

C. Control runoff from mixing and placing operations. Channel runoff directly to an approved collection system, within an on-site location approved.

D. Legally dispose of waste material, chemicals and solvents, and chemical containers off-site unless otherwise specifically allowed by these Specifications. Confirm any allowance for on-site disposal and dispose of waste on-site only upon receipt of written authorization.

E. All chemicals should be removed from construction site prior to hydro testing or any tank filling procedures.

1.09 DELIVERY, HANDLING, AND STORAGE

A. No cold weather work (outside temperature of 35-degrees and falling) will be permitted unless written permission is obtained from the Owner's representative. No wet-weather work will be permitted unless the work area is covered and protected. Protect materials from extreme cooling and rain.

B. Carry out all work in a manner that will prevent damage to the structural integrity of the adjacent exhibits and public areas, the waterproof gunite exhibit tank, window glazing or other physical features on site. Take extreme care in the handling of materials to prevent overloading of on-grade or hidden structures and to prevent physical damage to surrounding surfaces and waterproofing membranes. Protect surrounding surfaces from over-spray, staining, etc. Repair all damage to pre-existing structures, surfaces, and finishes to original conditions at NO COST to the Owner.

C. Delivery and Handling, general: Properly deliver and handle materials to prevent contamination, segregation, or damage to materials. Store materials in fireproof, weather-tight enclosures to protect against combustion, dampness and contamination. Prevent segregation and contamination of aggregates by proper arrangement.

D. Plastic Resins and Related Chemicals:

1. Store all materials in fireproof containers in area approved by the Owner, General Contractor, and local Fire Department.

2. Prevent interference of work by others as caused by fumes from on-site resin-related work. Coordinate all chemical work with the Owner's Project Manager, and if requested, monitor air quality to assure safe levels of resin-based fumes on the project site meeting current OSHA/NFPA requirements

1.10 PROJECT CONDITIONS

A. Examination of the site and general substrate and related conditions: The installer must examine the conditions under which the work under this Section is to be performed. Do not proceed with work under this Section until unsatisfactory conditions have been corrected.

B. Protect installed work from damage by other trades until acceptance of work. Provide required protection procedures.

C. Coordination: Coordinate with other work, and others whose work will be affected by this Section.

D. Work will occur within a facility that is unconditioned against heat, cold, or precipitation, and that it will be the responsibility of the Contractor to work in accordance with those conditions.

1.11 SEQUENCING, SCHEDULING, AND COORDINATING

A. Prior to commencing installation, arrange a job site meeting to be attended by the Contractor, the Owner's Representative and the representatives of other trades associated with the work of this Section and related Sections.

B. The purpose of the meeting shall be to discuss requirements of the Contract Documents, shop drawings, job and surface readiness and material storage and protection, to assure that details are correct, that materials shall be installed properly, and coordination of other trades.

C. Following the meeting, prepare a written report containing:

1. Meeting date, names and affiliations of those present.

2. Written statements from each installer and manufacturers' representative of their acceptance of the requirements of the Contract Documents for the use of their material.

D. The Contractor will be required to provide coordination documents that will assure that the work of this contract will be executed as intended.

E. Coordinate all work with adjacent trades and forms of construction relative to sequencing and compatibility of construction details and materials. Identify all points of coordination with other trades (such as plumbing, electrical, life support) and take all necessary measures to assure that the work of this contract is properly coordinated with the work of those other contracts.

F. Do not commence work of this Section unless documents required herein above have been approved.

1.12 WARRANTY

A. Warranty work listed in this Section for two years from date of Final Acceptance. Guarantees will include at a minimum:

1. Overall structural integrity of the work

2. Cracking of finish surfaces

3. Discoloration and/or the fading of color of finish surfaces

4. Accommodation of the Life Support System elements that placed (by others) within the exhibit tanks

5. Proper formation of rockwork in public areas relative to the prevention of visitor climbing of formations as well as the avoidance of sharp, pointed protrusions.

B. Provide two copies of written statement of warrantee, for Final Acceptance.

PART 2 - PRODUCTS AND INSTALLATION

2.01 DESCRIPTION

A. Substrate and Finished Exhibit Habitat Formations:

1. The exhibit construction for the habitat substrate shall include all materials, labor, equipment, and related services necessary to furnish and erect the exhibit including:

   a. Erecting and finishing of all sculpted and/or cast substrate over all necessary structural armatures.

   b. Placement of enhancements

2. The exhibit construction for the habitat does not include the following work that will be performed as indicated:

   a. Placement and installation of on-floor distribution piping, fiber-grate decking, in-tank piping and associated supports and other materials by Plumbing Contractor.

   b. Waterproofing of the structural tank structure.

   c. Lighting

3. All anchorages to be placed within the exhibit shall be set in place by the Contractor before starting the process of habitat substrate erection. The anchors shall be non-corrosive, and be the size, type, and quantity as indicated on the Contractor's shop drawings and data submittals. No anchors will be permitted below the water line and therefore they are not permitted to pierce waterproofing of the pool structure.

4. All below-water formations shall be grouted, solid-filled material unless otherwise agreed upon in writing by the Client. No metal or other corrosive materials will be allowed.

5. All above-water formations shall be lightweight construction that shall not exceed 120 per cubic foot, while still matching in appearance the adjacent and surrounding solid-grout formations that are within below-water locations.

6. The habitat work of this project has been represented by design drawings, a model and photo reference material. All formations, textures, visual accents, and coloration shall be in accordance with the intent of these documents and references.

2.02 MATERIALS

A. Waterproofing of Hand-carved and Pre-cast GFRC materials:

1. Heavy cement base, Thoro Systems Products Thoroseal, or approved equal, where noted on the Drawings

2. Crystalline capillary waterproofing, where noted on the Drawings, for application to all below-water formations and other formations where standing water or contact with saltwater may require that the materials be waterproofed shall be Vandex, Zypex or equal. The waterproofing system shall be a mix containing chemicals that penetrate with moisture into the capillary tracts and activate to form crystals that close the capillaries to produce the waterproofing effect.

3. Where noted on the Drawings, a cement-based waterproofing system shall be placed between the structural gunite coat and the texture coat. This cement-based waterproofing system shall be non-toxic, inorganic, free of calcium chloride and sodium based compounds. The cement-based waterproofing system shall be HEY'DI K-11, manufactured by HEY'DI American Corp., Norfolk, Virginia, or an equal. Bonding agents, if required, shall be HEY'DI SB Bonding Agent or an equal. Color to be approved by Exhibit Designer

B. Materials for Hand-carved Gunite and Glass Fiber Reinforced Concrete (GFRC):

1. Portland cement:

a. ASTM C 150, Type I, II or III.

b. For surfaces exposed to view in the finished structure use same brand, type, and source of supply throughout the GFRC production.

c. Cement to be rated as low alkali.

2. Aggregates:

a. Sand shall be washed and dried silica or approved equal with a history of successful use in similar formations. All sand shall pass through a No. 20 (850-pm) sieve.

b. Facing aggregates used should conform to ASTM C-33 except for gradation. Aggregates shall be clean, hard, strong, durable, inert, and free of staining or deleterious material.

3. Water: Free from deleterious matter that may interfere with the color, setting, or strength of the concrete.

4. Admixtures: Conforming to ASTM C260, ASTM C494 or ASTM C618.

5. Coloring Agent:

a. Shall be harmless to concrete set and strength.

b. Shall be stable at high temperature.

c. Shall be sunlight fast and alkali-resistant.

6. Glass Fiber:

a. Fibers specifically designed to be compatible with the aggressive alkaline environment of Portland cement based composites or fibers with a history of successful use in a Portland cement based composite that has been modified to be compatible with the fiber.

b. The producers of all Portland cement based composites shall submit evidence that the glass composition, Portland cement matrix, or both have been designed for glass fiber reinforced concrete applications.

7. Sprayed in Anchors and Loose Attachment Hardware:

a. Stainless steel ASTM A 666 Type 316, grade B anchor bolts ASTM A307 or ASTM A 325 for all saltwater exhibit applications.

b. Heavy duty, 100% nylon straps.

8. Cement Plaster: Pneumatically placed wet mixture of sand and Portland cement, minimum compressive strength of 4,000 PSI in 28 days.

9. Molding materials: At contractor's option to meet execution required.

10. Integral Color: Permanent cement colors.

C. GFRC Mixes

1. GFRC Mix: GFRC shall consist of Portland cement, water, glass fibers, sand, and may contain admixtures. The component materials shall be in accordance with Section 2.1.

2. Facing Mix: Thickness shall generally be the minimum possible to achieve the desired finish.

3. Coloring Agent: The amount of coloring agent shall not exceed 10% of cement weight.

D. Reinforcing Materials

1. Reinforcing Bars: Comply with ASTM A 615, Grade 40 or as noted. All reinforcing used in pool bottoms or other water containment area or areas continually exposed to water, shall have epoxy coating, unless otherwise noted. All epoxy coating shall be according to ASTM A775/A77M. Re-coating after installation may be required.

2. Welded Wire Fabric: 6 x 6-W2.1 x W2.1 WWF, comply with ASTM-185 or ASTM A 82. All WWF used in pool bottoms or other water containment area or areas continually exposed to water must have epoxy protective coating. All epoxy coating shall be in accordance with ASTM A775/A77M. Re-coating after installation may be required

3. Steel Lath: Unpainted 1.75 lb. black expanded metal lath, maximum 1/2-inch clear apertures is allowable for all above water applications only.

4. Spacers: Backup forms shall be fastened to reinforcing bars by means of special plastic tie wires.

5. Supporters for Reinforcement: Provide supports for reinforcement, supporting, and fastening plastic reinforcing bars and plastic mesh materials. Use only non-corrosive, non-metallic supports manufactured for that purpose. Corrosive materials and brick, stone and similar materials are unacceptable.

6. Wire: heavy-duty plastic zip-ties.

7. Plastic Reinforcement: Where indicated on the drawings, polypropylene mesh shall be incorporated into the texture coat of horizontal slabs to control freeze - thaw characteristics. The mesh shall be Tenax C-Flex or an approved equal which, when incorporated into cast specimens of concrete, shall demonstrate a modulus of rupture equal to or better than the performance of the same cast concrete specimens incorporating 6" x 6" - 10 Ga. welded wire fabric. The mesh shall be placed horizontally at a depth from the top of 1/3 the total depth of the final pour.

E. Pneumatically Placed Gunite

1. Definition: Pneumatically placed wet mixture of aggregate and Portland cement. Minimum strength of 3,000 PSI in 28 days.

2. Cements

a. Use cement conforming to one of the following:

1. Portland Cement conforming to ASTM C-150. Use only one brand of cement throughout the project.

2. Blended hydraulic cement conforming to ASTM C-595 type IS IS-A, IP or IP-A.

3. Aggregates

a. Standard Aggregates:

1. On gunite on the first floor on grade or on slab on grade shall use normal weight aggregates conforming to ASTM C-33.

2. Aggregates shall be manufactured from natural rock or stone, washed gravel either natural or crushed, clean, and free of deleterious substances.

b. Lightweight Aggregates:

1. All gunite referred to on the drawings as lightweight gunite shall use lightweight aggregates conforming to ASTM C-330-79.

2. Lightweight aggregate shall be either:

a. Clinkerized Clay equal to "Haydite", as manufactured by Hydraulic Press Brick Company, P.O. Box 31330, Cleveland, Ohio 44131, (216) 524-2950.

b. or Vitric Tuff (pumice) equal to “Tufflite”, as manufactured by Arizona Tufflite, Phoenix, Arizona, 85029, (800) 942-6368. Pumice should be pre-wet according to the manufacturer’s recommendations.

3. Total weight of lightweight gunite shall not exceed 118 pounds per cubic foot.

c. Structural Substrate - Gradation limit for combined aggregates conforming to the following:

Sieve Size U.S. Standard Square Mesh	Percent by weight passing individual Sieves
3/4 in.	100
1/2 in.	80-95
3/8 in.	70-90
No. 4	50-70
No. 8	35-55
No. 16	20-40
No. 30	10-30
No. 50	5-17
No.100	2-10

Batch fine and coarse aggregates separately to assure segregation.

d. Texture Coat - Gradation limit for combined aggregates conforming to the following:

Sieve Size U.S. Standard Square Mesh	Percent by weight passing individual Sieves
3/4 in.	------
1/2 in.	------
3/8 in.	100
No. 4	95-100
No. 8	80-100
No. 16	50- 85
No. 30	25- 60
No. 50	10- 30
No.100	2- 10

4. Water:

a. Mixing water: Use fresh, clean and potable mixing water or use non-potable water which produces mortar cubes having 7- and 28-day strengths equal to at least 90 percent of the strength of similar specimens made from water from a municipal supply. Make strength comparison on mortar cubes in accordance with ASTM C109.

b. Curing water: For finish gunite, use curing water that is free from elements that could cause staining.

5. Admixtures:

a. Use accepted admixtures meeting the requirements listed below, if admixtures are required or permitted. Except as otherwise accepted, dissolve soluble admixtures in water before introduction into the mixture. Agitate liquid admixtures that settle.

b. Chemical admixtures conforming to ASTM C494.

c. Air entraining admixtures conforming to ASTM C260.

6. Fly ash and pozzolanic materials conforming to ASTM C618.

7. Plasticizers and other admixtures that are permitted or required.

F. Moisture Retaining Cover

1. Burlap: Cloth made from jute and weighing approximately 9 oz. per sq. yd. For moist curing and conforming to AASHTO M 182.

2. Membrane Forming Curing Compound: ASTM C 309

G. Proportions

1. Submit for acceptance proportioning and test data from prior experience if available. If data from prior experience are not available or accepted, make and have tested specimens from three or more different mix proportions. Submit recommended mix proportions and test results for acceptance.

2. Gunite shall have a compressive strength at 28 days of full cure = 3000 PSI. Proportions shall be selected on the basis of compressive strength tests of specimens continuously moist cured until testing at 28 days. These specimens shall be cut from the gunite test panels not earlier than 5 days after gunite. For mix acceptance purposes, average core strengths shall be at least equal to full cure for cores with L/D of 2.0. For cores with L/D between 1.0 and 2.0, use the correction factors given in ASTM C 42. For cube specimens, average strength shall be at least equal to full cure = 0.85.

2.03 EXECUTION

A. Inspection

1. Verify that surfaces to receive Habitat Work and exhibit accessories materials are satisfactory for the installation. If unsatisfactory conditions exist, do not commence installation until such conditions have been corrected.

B. Preparation

1. Prepare all shop fabricated exhibit components as shown on the Drawings and in the appropriate Section of the Specifications.

2. Natural and Organic components: Collection, transportation and placement or installation shall be effected by the Contractor as shown on the Contract Documents as approved. Provide connections to secure natural materials in place as required by the Drawings.

C. Fabrication of GFRC Panels

1. Forms: Make latex molds (including backs) of natural rocks as submitted for GFRC panel production.

a. Forms for GFRC panels shall be rigid and constructed of materials that will result in finished products conforming to the profiles, dimensions and tolerances indicated by the Contract Documents and on the approved shop drawings.

b. Release agents shall be applied and used according to manufacturer's instructions.

2. Proportioning and Mixing:

a. All measurements of mix constituents shall be carried out in a careful manner to achieve the desired mix proportions.

b. The glass fiber and cement slurry shall be metered to the spray head at rates to achieve the desired mix proportion and glass content. These shall be checked in accordance with standard procedures described in PCI "Recommended Practice for Glass Fiber Reinforced Concrete".

c. Cleanliness of equipment and working procedure shall be maintained at all times.

3. Hand Spray Application:

a. Spray operators shall be trained personnel.

b. A mist coat consisting of the matrix without fiber may, if necessary, be sprayed onto the form. The thickness of this coating shall generally not exceed 1/ 8 in.

c. Spray-up of the main body of material shall proceed before any mist coat has set.

d. Application shall be by spraying such that uniform thickness and distribution of glass fiber and cement matrix is achieved during the application process.

e. Consolidation shall be by rolling or such other techniques as necessary to achieve complete encapsulation of fibers and compaction.

f. Control of thickness shall be achieved by using a pin-gauge or other approved method.

g. All over-spraying or hand forming of intricate details, incorporation of formers, embedment forms, fasteners, or infill material, shall be carried out before the material has achieved its initial set so as to insure complete bonding.

4. Inserts and Embedment:

a. Inserts shall be properly embedded in built up homogeneous GFRC layers to develop their strength.

b. Panel manufacturer shall test inserts to establish test data for use in design.

c. Rigid embedded items bonded to the GFRC shall not create undesirable restraint to volume changes.

d. Cover: Provide embedded anchors, inserts, and other sprayed in items with sufficient anchorage and Embedment for design requirements.

5. Tolerances:

a. Thickness:

1. Skin thickness ranging from +1/4” to +1/8”

2. Panel depth ranging from +1” to +1/4"

6. Finishes: Exposed face of panels to match approved sample. Exposed face of panels shall be manufactured free from joint marks, "grain" or other obvious defects.

7. Curing:

a. Immediately after the completion of spraying of the panel, a curing method shall be used to ensure sufficient strength for removing the units from the form.

b. After initial curing, remove panel from form and place in a controlled curing environment. Panels shall be kept continuously wet for a minimum of 7 days in accordance with manufacturer's standard curing practice. The temperature shall be maintained between 60°F and 90°F during this period.

8. Panel Identification:

a. Mark each panel to correspond to identification mark on shop drawings for panel location.

b. Mark each panel with date cast.

9. Acceptance: GFRC units, which do not meet the color and texture range or the dimensional tolerances may be rejected.

D. Preparation of Surfaces for Structural Substrate

1. Inspection: Examine the substrate, and the conditions upon which reinforcement is to be placed, and correct conditions which would prevent proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

2. Existing Tank Structure

a. Remove unsound material before applying substrate.

b. Prepare all structural contact or load-bearing points so as to assure proper contact, loading, or attaching, and to perform such work so as to maintain the structural and waterproof integrity of the tank structure.

3. Removable Forms:

a. Use form-coating material on removable forms to prevent absorption of moisture and to prevent bond with gunite.

b. Use a non-staining material for surfaces exposed to view when construction is completed.

c. The form-coating material shall not interfere with subsequent bonding to the gunite when this is required.

E. Structural FRP Reinforcing

1. Alternate Reinforcing Sizing: All structural FRP reinforcement is shown on the drawings and supplemented in these Specifications. The Contractor may, at their option, develop alternate reinforcement sizing and placement to facilitate their Work provided:

   a. Obtain written approval of the Project Architect/Engineer and the Owner.

   b. All structural calculations for alternate reinforcement are fully and clearly documented by a registered structural engineer, licensed in the State of Washington.

   c. Obtain required permits and approvals of such alternate sizing and placement, in a timely manner, without delaying the progress of the work, and at no additional expense to the Owner or their agents.

2. General:

   a. Clean reinforcement of loose material, mill scale, earth, ice, and other materials, which reduce or destroy bond between the fabricated elements and the existing tank structure.

   b. Touch-up bare exposed structural materials and surfaces of epoxy coated rebar with similar coating approved by manufacturer.

   c. Accurately position, support and secure reinforcement against displacement by construction or concrete placement operations. Locate and support reinforcing by plastic chairs, runners, bolsters, spacers and hangers, as required.

   d. Notify the Owner's Representative upon completion of reinforcing and prior to placing gunite.

3. Minimum Standards: Comply with specified standards for details and methods of reinforcement placement and supports, and as herein specified. The following minimum steel placement standards are supplemental to steel reinforcement schedules and notes on the drawings.

   a. Fabricate plastic bars of size and length indicated and accurately bend or form to the slopes indicated by methods that will not injure the materials. Fabrication shall be in accordance with the manual of Standard Practice for detailing Reinforced Concrete Structures, ACI 315.

   b. Provide sufficient numbers of supports and of strength to carry reinforcement. Do not place reinforcing bars more than 5 cm (2") beyond the last leg of any continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

   c. Position, support, and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by plastic chairs, runners, bolsters, spacers, and hangers, as required.

   d. Place reinforcement to obtain the minimum coverage for concrete protection. Arrange, space, and securely tie bars and bar supports together with 16 gauge wire to hold reinforcement accurately in position during concrete placement operations. Set wire ties so that twisted ends are directed away from exposed concrete surfaces.

   e. Place No. 4 bar as a key rod at intersections of plane surfaces.

   f. Lap bars (30) diameters at splices. With respect to viewing outer surface from a perpendicular viewpoint, lap bars on top of each other rather than side by side.

g. Place and bend bars around circles and curves, openings, corners and angles. Bends are to be permanently shaped, not sprung into place. Follow the outline of the rock formations to eliminate excess non-reinforced gunite outcroppings.

h. Tie reinforcing plastic to wall ties and to extended footing, or wall.

i. The tie bars and tie anchors which are exposed to air and which do not come in contact with any backfill material shall be given a protective covering of epoxy, or equal.

j. Tie bars and tie anchors that come in contact with backfill material will be encased with a coating of gunite. Plastic shall be covered by a minimum of 1" of gunite.

k. Use additional #4 bars diagonally across corners of openings and wherever gunite formations act as beams. Place additional #5 bars at points of maximum stress, i.e., one in top and one in bottom extending 12" into supports.

l. Place mesh on plastic reinforcing on side opposite the backup material and plastic tie securely to the reinforcing bars at not less than 20 inch intervals in both directions. Lap mesh minimum 2 inches at adjacent ends.

m. Install plastic mesh fabric in as long lengths as practicable. Lap adjoining pieces at least one and one-half (1-1/2) meshes plus end extension of wires, but not less than 12 inches in slab on grade. Extend mesh across supporting beams and walls. Provide adequate support for mesh to ensure proper location. Place uniformly 1-1/2" to 2" from finished surface.

n. Installation of reinforcing to be complete in every way by end of working day prior to placement of concrete.

o. Unacceptable Materials: Reinforcement with any of the following defects will not be permitted in the work.

1. Bar lengths, depths, and bends exceeding specified fabrication tolerances.

2. Bend or kinks not indicated on drawings or final shop drawings.

3. Bars with reduced cross-section due to excessive rusting or other cause.

F. Forming Gunite Structures

1. Where gunite is constructed within (or near) the exhibit tanks, use plastic rebar and mesh materials (no metal products will be allowed)

G. Provisions for Other Trades

1. General:

a. Provide openings in gunite formwork to accommodate work of other trades and allow access for husbandry staff. Determine size and location of openings, vents, access holes, recesses, and chases from trades providing such items, as well as the husbandry staff.

H. Batching and Mixing Gunite

1. Mixing Proportions: Control by weight batching, or by volume batching meeting the requirements of ASTM C685.

2. Batching and Mixing Equipment: Use batching and mixing equipment capable of proportioning and mixing ingredients at a rate that will provide adequate production and with an accuracy that will insure uniformity of batches. Weighing equipment shall be capable of batching with the accuracy specified in ASTM C94. Volumetric equipment shall be capable of batching with the accuracy specified in ASTM C685.

3. Ready Mixed Concrete: Ready-mixed concrete shall comply with ASTM C94, except that it may be delivered to the gunite equipment in the dry state if that equipment is capable of adding the water and mixing it satisfactorily with the dry ingredients, or with ASTM C685, in which case the ingredients are delivered dry and proportioned and mixed at the site.

I. Placing Gunite

1. Textured gunite: Gunite shall be placed in two separate applications unless otherwise or indicated on drawings.

a. Structural Substrate: The first application shall be a structural substrate, capable of maintaining the intended shape and supporting live and dead loads as specified or required by codes.

b. Texture Coat: The second application shall produce the intended color and texture, and shall be placed only after bonding agent has been applied. Where applicable, surface conditions must comply with specification requirements.

2. Gunite as a structural base for GFRC panels: Gunite shall be placed in one application.

3. Place gunite using suitable delivery equipment and procedures that will result in gunite in place meeting the requirements of this specification. Refer to ACI Standard 506-66, Recommended Practice for Gunite.

4. When applying any Gunite (or other concrete material) the Contractor must make sure all plumbing and other systems are thoroughly capped.

5. Placement Techniques:

a. Control thickness, method of support, air pressure, and/or water content of gunite to preclude sagging or sloughing off. Discontinue gunite or provide suitable means to screen the nozzle stream if wind or air currents cause separation of the nozzle stream during placement.

b. Dampen absorptive substrate surfaces prior to placement of gunite to facilitate bond and to reduce the possibility of shrinkage cracking developing from premature loss of the mixing water.

c. Broom or scarify the surface of freshly placed gunite to which, after hardening, additional layers of gunite are to be bonded. Dampen surface just prior to application of succeeding layers.

d. First, fill with sound material corners and any area where rebound cannot escape or be blown free. Complete the corners between the web and the flanges of structural steel before application to the flat areas.

e. Provide a supply of clean, dry air adequate for maintaining sufficient nozzle velocity for all parts of the Work and, if required, for simultaneous operation of a suitable blow pipe for clearing away rebound.

f. Protect existing and new supply ports to prevent gunite material from entering any pipe openings.

6. Placement Around Reinforcement:

a. Hold the nozzle at such distance and angle to place material behind reinforcement before any material is allowed to accumulate on its face. In the dry-mix process additional waste may be

added to the mix when encasing reinforcement to facilitate a smooth flow of material behind the bars.

b. Do not place gunite through more than one layer of reinforcing rods or mesh in one application unless demonstrated by pre-construction tests that the reinforcement is properly encased. Test to ascertain if any voids or sand pockets have developed around or behind reinforcement by probing with an awl or other pointed tool; by removal of randomly selected bars; or by coring or other suitable means.

7. Cover of Reinforcement:

a. Place gunite to provide the following minimum cover over reinforcement:

1. For gunite used as lining or coatings: 3/4 in. for fine aggregate gunite and 1-1/2 inc. for coarse aggregate gunite.

2. For reinforcement in slabs and walls: 3/4 inc. for fine aggregate gunite and 1-1/2 in. for coarse aggregate gunite.

3. For principal reinforcement in beams, girders and columns: 1-1/2 in.

b. Minus tolerance on cover shall be 3/8 in., except that it shall not be greater than one-third of the specified cover.

8. Line and Thickness Control: Use adequate ground wires or other accepted means to establish the thickness, surface planes, and finish lines of the gunite. Maintain specified tolerances by keeping ground wires secure and taut.

9. Placement Precautions:

a. Do not place gunite if drying or stiffening of the mix takes place at any time prior to delivery to the nozzle. Do not use rebound or previously expended material in the gunite mix.

b. Remove overspray or rebound prior to final set and before placement of gunite material on such adjacent surfaces.

10. Joints

a. Construction joints shall be designed and located by Contractor and approved. Submit shop drawings of all construction joints.

1. Taper construction joints to a shallow edge form, about 1 in. thick, except where the joint will be subjected to compressive stress. In this case, use non-tapered joints and take special care to avoid or remove trapped rebound at the joint.

2. The entire joint shall be thoroughly cleaned and wetted prior to the application of additional gunite.

3. Make joints perpendicular to the main reinforcement. Continue reinforcement across joints.

b. Control Joints: Install control joints in accordance with the shop drawings. Do not extend reinforcement or other embedded metal items, which are bonded to the gunite, continuously through control joints.

c. Aesthetic Joint Placement: Position construction and control joints to conform to the locations of natural occurring cracks and joints in the simulated rock and earth forms as shown in drawings and photographs.

11. Repair of Surface Defects

a. Remove and replace gunite which lacks uniformity, exhibits segregation, honeycombing, or lamination, or which contains any dry patches, slugs, voids, or sand pockets. Remove and replace damaged in-place gunite.

b. Repair core holes in accordance with Chapter 9 of ACI 301. Do not fill core holes with gunite.

c. Replace any gunite that subsides after placement.

12. Verification of Structural Loads

a. Contractor is responsible for verifying the anticipated weights for all replicated habitat work on a tank-by-tank basis prior to the commencement of any habitat formation work.

J. Preparation of Surfaces for Texture Coat

1. Structural Cracks:

a. Structural sized cracks (appearing after a duration of 2 to 4 days duration) should be opened, cleaned and repaired with a 3:1 mix of sharp sand and Portland cement mixed with a solution of 1 part bonding agent to 5 parts water or a patching material recommended by the cement-based waterproofing manufacturer.

b. Moving or dynamic cracks should be treated as expansion joints with HEY'DI K-11 and an elastic sealant in accordance with sealant manufacturer's instructions.

2. Waterproofing shall be provided for all below-water habitat features. The structure coat should be thoroughly cleaned and dampened. Apply one slurry coat of HEY-DI or equal cement-based waterproofing at the rate of 2.25 lbs. per sq. yd. After it has reached an initial set, dampen if dry and apply a second coat of the cement-based waterproofing at the same rate. Pour concrete while the second coat is still less than 6 hours old to assist in bonding and to form an uninterrupted membrane.

K. Finishes

1. Structural Layer:

a. Provide broom finish on areas to be waterproofed.

b. Do not scrape or cut to remove high spots until the gunite has become stiff enough to withstand pull of the cutting device.

2. Texture Coat:

a. The Contractor will provide an expert(s) to perform texturing, shaping and coloring of the Texture Coat

b. The procedures for applying the texture coat materials and the personnel for this work must be reviewed and approved.

c. Finished product of the Texture coat shall simulate natural formations of sand, rock and mud as described in the specifications and drawings, and photographs.

d. The preserved existing rockwork will be modified by the Contractor whereby they will integrate the appearances of the new construction with that of the existing construction to create a seamless, naturalistic appearance in terms of texture, geological formation, fault lines, and color.

e. Verification of Structural Loads and Strength

1. The Contractor will load test and verify that all formations are structurally sound and allow for the physical weight of staff divers (or others) being set upon any formation by applying 80 pounds per square foot of load on all walking/standing surfaces for a period of no less than twenty-four (24) hours. Do not allow persons in the area during the loading period.

2. In the event of test failure, the Contractor will remove the necessary material until such time as the test is satisfactorily passed.

L. Curing and Protection

1. Initial Curing: Immediately after finishing, keep gunite continuously moist for at least 24 hours. Use one of the following materials or methods.

a. Ponding or continuous sprinkling.

b. Absorptive mat or burlap fabric, sand, or other covering kept continuously wet.

c. Continuous steam (not exceed 150 F) or vapor mist bath.

d. Curing compounds and application. Comply with ASTM C309. On natural gun or flash finishes, use twice the normal application rate recommended by the manufacturer, or 100 S.F. per gal., whichever is less. Do not use curing compounds on any surfaces against which additional gunite or other cement-based finishing materials are to be bonded unless positive measures, such as sandblasting, are taken to remove curing compounds completely prior to the application of such additional materials.

e. Do not use curing compounds on texture coat, structural layer which is to receive texture coat, or any surface against which additional gunite or other cement-based finishing materials are to be bonded.

f. Employ positive measures, such as sandblasting, to remove over-sprayed curing compounds completely prior to the application of such additional materials.

2. Final Curing: Provide additional curing immediately following the initial curing and before the gunite has dried. Use one of the following materials or methods:

a. Continue the method used in initial curing.

b. Materials conforming to "Specifications for Sheet Materials for Curing Concrete", (ASTM C171).

c. Other moisture retaining coverings as accepted.

3. Formed surfaces: If forms are to be removed during curing period, immediately use one of the curing materials or methods listed in Paragraph 3.12 - A. Continue such curing for the remainder of the curing period.

4. Duration of curing: Continue curing for the first 7 days after gunite, or for the first 3 days if high-early-strength is obtained. During the curing period, maintain gunite above 40° F and in a moist condition. Prevent rapid drying at the end of the curing period. Advise and seek approvals from the General Contractor's Project

Manager and Owner (and the Owner's Design Team) for planned curing durations and a back-up schedule should additional curing time be necessary.

5. Natural curing: Natural curing may be allowed when authorized and approved if atmospheric conditions surrounding the gunite are satisfactory, such as, when the relative humidity is at or above 85 percent.

6. Curing will require acid etching with a stabilized ph of 8.0 to 8.2 for a minimum of 24 hours for this closed saltwater system.

M. Erection of GFRC Units

1. Unloading Areas and Access: Clear, well-drained unloading areas and road access around and in the building where possible and appropriate shall be provided and maintained by the Contractor to a degree that the hauling and erection equipment for the GFRC units are able to operate under their own power.

2. Safety Aspects: The erector shall provide adequate barricades, warning lights or signs to safeguard traffic in the immediate areas of hoisting and handling operations.

3. Setting:

a. GFRC units shall be lifted with suitable lifting devices at points provided by the manufacturer. Place cast rock panels into proper position (referring to numbered photographs, molds, and panels) shimmying and bracing as necessary, and wire-tie or weld cast-in steel reinforcing rod anchors to supporting steel reinforcing bar grid work, then shoot seams between panels and vertical or horizontal line for formation.

4. Supports and Bracing: The erector shall provide temporary supports and bracing as required to maintain position, stability and alignment as units are being permanently connected.

5. Secure Panels to structural armature or substrate:

a. Secure GFRC units in place by strapping and grouting, or as shown on approved erection drawings.

6. Finishing and seaming

a. Apply cement plaster with integral color directly to those areas of gunite walls that are to be hand carved mud or dirt banks, dens, floors, or pools that are to be hand carved as to a minimum depth of 1-inch. Increased depth of material will be at no increase in contract sum. Hand-carve these areas to truly approximate the approved photographs and model.

b. Waterproof over smooth cement plaster coat of wall planters.

c. Waterproof all pools integrally watertight as well as water tight at junctures with walls constructed by others as required.

d. Habitat Work shall meet all buildings, walls, doorframes, etc., with no voids.

e. In Habitat Work for underwater locations, no voids are allowed in the finished construction

N. Coloring

1. Paint artificial rock to mimic photographs of natural formations, and approved panels. As this is an artistic endeavor, the finished painting shall be approved by the Owner's Representative at frequencies which allow the work to progress without interruption and which will avoid requiring major repainting effort. Minor adjustment to final product shall be made at no increase in contract sum.

a. Surface Applied Color:

1. Color of rock and sand forms shall match the color (in general and in detail) of natural materials displayed in the photographic samples.

2. Color hand-carved texture coat and pre-cast GFRC panels with integral color agents and by painting after final texturing. Staining and etching may be used in specific circumstances approved by the Owner's Representative. Color shall be approved by the Owner's Representative without exception.

3. Paint shall be flat finish unless otherwise specified.

4. Color mixes and application processes shall be approved by the Owner's Representative prior to beginning of Work.

b. Integral Color of Cementitious Materials

1. Use integral color that matches the base color of the habitat being produced.

2. Integral color(s) to be approved by Owner and the Exhibit Designer prior to commencement of work.

3. Where designated, adhere Owner-supplied crushed coral or loose sand/gravel to tank bottom using clear epoxy resin as the adhering agent, with sand broadcast over tank bottom area sufficient to hid entire tank bottom.

2.04 CLEANING

A. Cleaning methods shall be proposed by Contractor for approval.

B. After Installation: Contractor to provide domestic freshwater wash of entire tank after all exhibitry (includes artificial rockwork, natural rock, etc.) is complete but before substrate (gravel, sand - if applicable) is installed. Intent is that all surfaces of the tank and exhibitry are spray washed and the entire tank is filled prior to draining

2.05 PROTECTION

A. The Contractor shall be responsible for protecting their Work from any damage, and repairing to former quality any damage, occurring during construction.

B. The erector shall be responsible for any chipping, concrete spalling, cracking or other damage to the units after delivery to the jobsite.

2.06 INSPECTION AND ACCEPTANCE

A. Make habitat work and all related scope ready for review of all operational, technical, biological, and aesthetic aspects. Correct all deficiencies as directed.

1. Final inspection and acceptance of completed Habitat Work shall be made to verify conformance with plans and specifications.

2.07 REPLICATED ENHANCEMENT CORALS

A. A schedule of species-specific enhancement corals are attached to this specification.

2.08 PHOTOGRAPHIC REFERENCE MATERIAL

A. Photographic reference photographs are attached to this specification. These photos maybe shown in black and white during the documentation and bid phases of the project, with color versions made available upon the successful award of this scope of work, and upon the commencement of the construction phase of work.

END OF WRITTEN SECTION – ENHANCEMENT CORALS AND PHOTO REFERENCE MATERIALS FOLLOW

SECTION 11 59 30

INTERPRETIVE GRAPHICS

PART 1 - SUMMARY OF WORK

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this Section.

1.2 SUMMARY

A. The Contract Forms, Conditions of this Contract, and Section 11 59 01 applies to the work of this section.

B. The Contractor is expected to be familiar with all other sections of the specifications and drawings as issued for Exhibits and may need to familiar with specification and drawings as issued for Architecture and Engineering

C. Related Specification Sections include:

1. 11 59 01 - General Requirements for Exhibits
2. 11 59 40 - Media Software for Exhibits
3. 11 59 70 - Exhibit Casework & Furniture

1.3 SCOPE OF WORK

A. The work under this Section consists of the furnishing and installing of printed interpretive exhibit graphics and wall murals as outlined by the schedule of graphics indicated within the drawing set with the prefix of EX. Interpretive graphics include the following:

1. Non-interactive Wall Graphics
2. Dimensional Letters
3. Interactive Wall Graphics (Wall mural with interpretive text and images built into a series of movable, interactive wall elements.)
   a. Puget Sound Interpretive Wall Graphic
   b. Timeline Interpretive Wall Graphic
4. Photo Mosaic Wall Graphics
5. Conservation Station Graphics

C. Refer to schedule of graphic elements located within the drawings that will identify all graphic elements, their size, material, and corresponding locations.

D. Work includes all mounting structures, themed or otherwise, as these structures will be deemed an integral part of the presentation of graphics within the project.

1.4 WORK BY OTHER CONTRACTORS

A. Work, when noted on the Drawings as “by Owner,” “by other contractors,” or “existing,” potentially including landscape, architectural structures and walls, all cabinetry and casework, graphic backing and mounting systems, exhibit artifacts, painting, architectural finishes, mechanical, electrical, and plumbing equipment, are not in the Scope of Work described in this Section.

1. All on-screen media graphics are part of the media software scope of work, and as such are not part of this specification section, though the Exhibit Designer and/or Client will art direct those on-screen graphics through the provision of typical screen templates and graphic standards provided by the Exhibit Designer.

2. Graphic layouts and their corresponding digital files will be designed and produced by the Exhibit Designer, and supplied to the Interpretive Graphics contractor for output, mounting, delivery and installation.

B. The Exhibit Designer, will continue work past the point of final Construction Documentation phase work, and will in fact deliver all graphic files to the Interpretive Graphics contractor after the award of their contract. It is anticipated that the final delivery of all digital files to the Interpretive Graphic Contractor will occur approximately four to four months after the date that this contract has been awarded. All electronic mechanical artwork inclusive of all text, photography, illustrations, maps, etc. will be delivered to the Interpretive Graphic Contractor in Illustrator CS5 (or equivalent).

1.5 SUBMITTALS

A. Submittals will include Product Data and Written Information, Samples, Proofs, Full Size Mock-ups, Work-In-Progress Photographs, and Administrative Submittals.

B. Make submittals of Product Data and Written Information, Full Size Mock-ups, Samples, Proofs, Work-In-Progress Photographs, and Administrative information in a timely manner as required by the Drawings and in this and related sections of the Specifications.

C. No Work shall be done except from issued digital files and related Contract Documents, unless otherwise approved.

D. Review shall not act to relieve the Graphics Contractor from responsibility for accuracy of the fabrication and installation details and placing diagrams. Dimensions and locations to be verified by the Contractor prior to the presentation of Shop Drawings.

E. Pre-Production Control Drawings:

1. Pre-Production Control Drawings shall be submitted by the Graphics Contractor for review when the Graphics Contractor sees a need to install a component of the Work in a manner which differs from the appearance, character or sizes detailed in the Construction Drawings and/or the shop drawings issued by the Cabinetry Contractor.

2. Review, coordinate and verify all exterior site locations with Construction Manager (and referring to the appropriate documents provide by the Architect and their engineers) in order to assure that all elements are properly accounted for, located, and that all utilities and other general conditions are in accordance with the documents.

F. Product Data and Written Information

1. Submit proposed materials and finishes. Include test data histories of proposed materials and finishes.

2. Submit reports for long-term durability and integrity of any features covered by this scope of work.

3. Submit data for proprietary materials, processes, and items as requested by the Exhibit Designer.

G. Samples

1. Upon the request of the Exhibit Designer and prior to or immediately upon the award of the contract, the Graphics Contractor may be required to submit samples indicating general character, shape,

texture and durability of selected features required under this project. Samples shall be @ 2' x 2'. Samples shall represent the finished surfaces, texture, coloring, etching, etc., as shown on the documents or as directed by the Exhibit Designer.

a. No fabrication of the final Work shall begin prior to approval of samples.
b. Samples shall not be removed until the completion of Work.
c. Rejected samples shall be resubmitted for approval at no additional cost to the Owner until approval is met.

2. Furnish representative samples of finishes and materials for material testing, as may be required by the Exhibit Designer and the Owner's Project Manager.

3. Provide one individual samples of each graphic feature for each exhibit program area or type at 24" x 24" (or actual size if smaller than 24" x 24") showing colors, quality, and resolution for each application.

4. Samples to include:
   a. All materials and processes to be incorporated into the project unless otherwise stated by Interpretive Exhibit Designer.

H. Proofs

1. All work to be produced within this scope will be submitted in paper proof format sufficient for the Owner, Contract Officer, Architect and Exhibit Designer the opportunity to review all graphics prior to going into final production and to assure that all digital files maintain their original content, as given to the fabricator by the Exhibit Designer.

I. Administrative Submittals

1. Description of planning, equipment, methods and quality control program.

2. Construction schedule. Coordinate with the general construction schedule per Contract Requirements.

3. Graphics Contractor qualifications, as noted below, will be submitted with the bid.

1.6 QUALITY ASSURANCE

A. Qualifications an Interpretive Graphic Contractor:

1. A responsive bid will be by an Interpretive Graphic Contractor, including those above, who meet the following qualifications; evidence of which shall be submitted with the bid.
   a. Established firm with a minimum of ten (10) years experience in successfully constructing museum quality exhibits of similar nature to the project.
   b. The Interpretive Graphics Contractor shall submit with their bid full documentation of their personnel, including superintendent and fabrication personnel, detailing to the Owner and Exhibit Designer's satisfaction the experience of each person listed, including visual portfolios showing key individuals' prior work, and their ability to perform all phases of the Work. The Exhibit Designer reserves the right to request changes in the Interpretive Graphic Contractor's personnel in order to obtain the highest level of talent available from that organization for this project. Submittal shall also detail physical facilities and established quality control procedures, and a management capability sufficient to produce the required units without causing delay of the project.
   c. The Interpretive Graphics Contractor shall submit a list of four (4) recent, completed installations. The list shall indicate the project name and location, project budget for the Contractor's portion of the Work, the Architect, and the name, address and phone number of the Exhibit Designer.
   d. The Interpretive Graphics Contractor shall submit photographic proof as references of his/her experience and ability to construct exhibit features similar to those shown on the

drawings and as listed within these specifications. These materials shall be used to evaluate the Contractor's ability and experience to perform this Work.

e. Sustainable Design Best Practices: Provide written statement outlining the sustainable design program(s) practiced by the fabricator and how those programs (inclusive of sources, materials and fabrication) will be utilized for this project.

B. Design Criteria Regarding Graphics Work:

1. It is intended that the finished products of Work in this Section are easy to read, clear, durable, high quality products that are aesthetically pleasing to look at.

2. The graphic Work, while serving as a tool for communication, is also artistic in nature and may require adjustments to obtain the desired effect. The Exhibit Designer and Owner will decide questions of aesthetic effect. The Owner will decide questions of biological and scientific accuracy of all visual and written graphic content.

3. General graphic will include all text copy, final photos, maps and illustrations. The conclusion of Graphic Production phase of work will result in the delivery of final files in CD/DVD format ready for production. Deliverables may occur over several submittals.

a. Photos larger than 12" in length or width will require high resolution scanning in order to achieve an acceptable finish of those images. These images will appear for position only within the graphic files, however, originals (prints, transparencies, negatives, etc) will be supplied to the Contractor in order to have high-resolution scans produced.

4. Prior to producing final exhibit graphics, on-site reviews of selected graphic elements may be required for review with the Owner.

5. The installation of all Work under this Section shall be performed by the Graphic Contractor. No Work shall be executed without the Graphics Contractor being present on the premises.

C. Graphic Production and Materials Source Quality Control:

1. The Graphics Contractor shall have an established Quality Control program in effect prior to letting of the contract. A copy of this program shall be submitted to the Contract Officer.

2. Testing of materials and inspection of production techniques shall be the responsibility of the manufacturer.

3. The Graphics Contractor will keep quality control records available for two years after final acceptance.

4. Testing Graphic Materials:

a. A quality control program shall be in effect to monitor photographic-based materials color quality, stability, and longevity. Results of such quality control tests and evaluation of such tests shall be available to the Exhibit Designer upon request.

b. Preparation of the tests and test procedures shall be in accordance with industry standards for exhibit graphics, especially as it relates to quality control.

c. Testing of materials for ability to withstand extreme UV exposure, heat, and humidity will be required. It is recommended that the Contractor provide 2 sets of samples of all materials for testing, with one sample being placed outdoors with full exposure, and the other kept locked in a safe place as a control set for comparison. Test period to be as long as possible prior to initiating production of final graphics.

D. Exhibit Designer's Direction Regarding Graphics Work:

1. It is intended that the finished products of Work in this Section are high quality, durable, and aesthetically attractive graphics, as shown in the Construction Drawings, and other referenced

materials, as specified herein.

2. To achieve this work, the Interpretive Graphics Contractor will coordinate and cooperate fully with the Exhibit Designer, Architect, and Owner's Project Manager.

3. All Work in this Section shall be performed under the observation and review of the Owner, Contract Officer, Architect and Exhibit Designer.

4. The Exhibit Designer explicitly reserves the right to continuously monitor the Work for aesthetic quality and to assume control of the Work through direction of the Graphic Contractor's job superintendent until specified effects are achieved.

1.7 STANDARDS

A. Quality Standard: Except as otherwise indicated, comply with industry standards for museum quality graphic materials and processes and conform to manufacturers' recommended procedures:

1.8 PROTECTION OF PROPERTY

A. In addition to normal precautions for the protection of the public, workers and property, take special precautions to prevent and damage to adjacent exhibit and/or architectural surfaces within the exhibit galleries that make up this project.

B. Limit the area for working and storing any chemical materials required for installation to areas within ten horizontal feet of exhibit structures and other areas specifically approved by the Owner's Project Manager.

C. Properly use the project site ventilation system (provided by others) in any work area where chemicals are being used. Review the ventilation system to confirm that it will comply with all local, state, and Oklahoma's regulatory agency requirements based upon the work of this contract and prior to use.

D. Legally dispose of waste material, chemicals and solvents, and chemical containers off-site unless otherwise specifically allowed by these Specifications. Confirm any allowance for on-site disposal with the Owner's Project Manager and dispose of waste on-site only upon receipt of written authorization from the Owner's project Manager.

1.9 DELIVERY, HANDLING, AND STORAGE

A. Carry out all work in a manner that will prevent damage to the structural integrity of the building, building finishes, window glazing or other physical features on site. Repair all damage to building structure, surfaces, and finishes to original conditions at no increase in contract sum.

B. Delivery and handling, general: Properly deliver and handle materials to prevent damage to materials. Store materials in fireproof, weather-tight enclosures to protect against combustion, dampness and contamination.

C. Do not deliver the Work of this section until operations and work by other contractors, that could possibly damage or impact the finished quality of the Work, has been completed. If work must be stored in other than installation areas, store only in areas whose environmental conditions are comparable to those of the finished installation location.

1.10 PROJECT CONDITIONS

A. Examination of the exhibit area and general architectural surfaces and related conditions: The installer must examine the conditions under which the work under this Section is to be performed, and notify the Owner's Project Manager of any unsatisfactory conditions. Do not proceed with work under this Section until unsatisfactory conditions have been corrected in a manner acceptable to the installer.

B. Protect installed work from damage by other trades until Exhibit Designer and Owner's acceptance of work. Advise Construction Manager of required protection procedures.

C. Coordination: Coordinate with other work, and other contractors and subcontractors whose work will be affected by the Interpretive Graphics scope of work.

1.11 SEQUENCING, SCHEDULING, AND COORDINATING

A. Prior to commencing installation, arrange a job site meeting to be attended by the Interpretive Graphic Contractor's representative, the Owner, the Exhibit Designer, the Construction Manager and the representatives of other trades associated with the work of this Section and related Sections.

B. The purpose of the meeting shall be to discuss requirements of the Contract Documents, shop drawings, job and surface readiness and material storage and protection, to assure that details are correct, that materials shall be installed properly, and coordination of other trades.

C. Following the meeting, prepare a written report containing:

1. Meeting date, names and affiliations of those present.

2. Written statements from each installer and manufacturers' representative of their acceptance of the requirements of the Contract Documents for the use of their material.

3. Identify all contract-related issues, concerns or questions regarding:
   a. Scope of work and related fee
   b. Project and scope specific schedule
   c. Coordination and sequencing of work
   d. Completeness of documents
   e. Comprehension of all requirements

D. Do not commence work of this Section unless documents required herein above have had their final review by the Exhibit Designer and Owner.

1.12 GUARANTEE

A. Guarantee Work listed in this Section for one year from date of Final Acceptance.

B. Identify products with warrantees greater than one (1) year and provide written confirmation of those warrantees.

C. Provide warrantees against degradation of materials against UV exposure, heat, humidity, and general wear from normal visitor use.

D. Provide two copies of written statement of guarantee, satisfactory to the Exhibit Designer and Construction Manager prior to Final Acceptance.

PART 2 - PRODUCTS AND INSTALLATION

2.1 DESCRIPTION

A. Refer to the schedule of graphics (included within the EX drawing series) for a summary of all Interpretive Graphic scope of work.

2.2 MATERIALS

A. General Description of Materials

1. Chromogenic "C-print" graphics, (Lambda, LightJet or equivalent) mounted to substrate to require that all edges be protected and/or out of reach of the visitor.

2. High pressure laminate imbedded graphics (HPL) mounted to rigid substrate with continuous edge band as noted on drawings and graphic schedule.

3. Exterior grade printing on Tyvek brand (or equivalent) water resistant paper.

4. Digital Wallpaper Mural: inkjet printed on roll adhesive vinyl.

5. Painted Sintra sheet material

6. Dimensional letters mounted and painted.

7. Paint, to be used as direct application of graphic and as required on edges of graphics, dimensional letters, or as in-fill for CRC formed elements.

B. High-resolution Chromeogenic prints (e.g. Lambda, LightJet or eq.):

1. Mounted to rigid substrate and then to wall or exhibit structure. Thickness of substrate to match notes on drawings or graphic schedule. Use MDF board or, Dibond, Sintra or approved equivalent.

2. All applications of this material to require that all edges be protected and effectively kept out of the visitors' reach. All prints to have a protective vinyl overlam, applied without creases, cuts or bubbles.

3. Unless otherwise noted, vinyl surface should be matte and resistant to fingerprinting.

4. Applications to be in accordance with manufacturer's recommendations and industry standards.

5. Graphic medium should conform to requirements of the project and provide the Owner with a robust product suitable for the application within this project.

6. Use graphic medium as appropriate in lieu of HPL, provided it conforms with requirements of the project.

7. Applications to be in accordance with manufacturer's recommendations and industry standards.

8. Unless otherwise stated, C-print graphics and HPL graphics in match appearance and finish and should be mounted so that they finished product conforms to the thicknesses being produced for the HPL graphics.

9. All C-print graphics to be mounted onto rigid wall substrate backing of MDF board or approved equivalent for interior applications and on Sintra, aluminum or approved equivalent.

C. High pressure laminate embedded graphics (HPL)

1. Use Folia, Fossil, I-Zone brand or equivalent HPL as graphic medium as noted in the drawings.

2. Applications to be in accordance with manufacturer's recommendations and industry standards.

3. Unless otherwise stated, HPL graphics to be 1/16".

4. All HPL graphics to be mounted onto rigid wall substrate backing of MDF board or approved equivalent for interior applications and on Sintra, aluminum or approved equivalent for exterior applications.

D. Digital Wallpaper: High-resolution Inkjet prints onto lightly textured self-adhesive calendared vinyl with matte finish, flame retardant.

E. Paint:

1. For general painting use Benjamin Moore brand, Sherwin Williams, brand or equivalent paint applied according to manufacturer's recommendations and industry standards.
   a. Exterior satin finish oil paint on all exterior elements
   b. Interior satin finish oil paint on all interior elements

2. Polane brand paint or equivalent aircraft paint system for aluminum applications.

3. Surfaces to be painted using the colors provided to the fabricator at a later date (as the final colors will have to be coordinated with the graphics and as such will not be available approximately three months after contract signing.

F. Dimensional Lettering:

1. Post-mounted, painted acrylic, metal or wood letters.

2. Custom acrylic dimensional letters to match specified fonts and sizes.

3. Custom hand-crafted letters to match appearances shown in graphic layouts

4. Paint to match specified colors, paint brand and finish.

5. Use metal letters (aluminum or stainless steel) where noted

6. Mount to specified surfaces using manufacturer-recommended adhesives or fasteners. May require adhesive backing and/or silicone adhesive to wall surface. May require post-mounted. Where rusticated appearance is called for, method of fastening may intentionally require additional decorative "theming" to create appearance of non-traditional, culturally accurate graphics. Refer to drawings for further details.

G. Backing Materials

1. Medium Density Fiberboard (MDF - typical unless otherwise specified)

2. Dibond (aluminum composite panel)

3. Sintra (painted)

4. Acrylic panel (color and thickness TBD)

5. Aluminum

6. Masonite (suitable for interior applications only)

H. Photo Mosaic

1. Environmental photographic element in which a macro-image is created using of thousands of micro-image "pixels" (2" square each) arranged into a single output image file by a proprietary software provided by Runaway Technology, Inc. Printed onto self-adhesive calendared vinyl (non-stretching). Installed on wall built by GC.

2.3 EXECUTION

A. Inspection

1. Verify that surfaces to receive graphic materials are satisfactory for the installation. If unsatisfactory conditions exist, do not commence installation until such conditions have been corrected.

2. Review all graphic elements relative to adjacent interactive or media-based exhibit features to assure that all work is coordinated.

3. Field verify the dimensions and geometry of all surfaces upon which graphics are to be applied.

B. Preparation

1. Prepare all shop fabricated exhibit components as shown on the Drawings and in the appropriate Section of the Specifications.

2. For all items covered by this scope of work:
   a. Clean substrate, removing projections and substances detrimental to the work; comply with recommendations of manufacturer of products to be installed for proper preparation procedures.
   b. Comply with combined printed recommendations of all manufacturers, except where more stringent requirements are indicated.
   c. Protect all work from edge damage during handling and installation. Remove from Project and dispose of all work with edge damage or other imperfections, when installed, weakens the intended structural qualities of the exhibit and/or impairs the intended performance and aesthetic appearance of the finished exhibit.
   d. Apply surface primers to substrates and/or joint surfaces where required for adhesion of sealants, as determined by pre-construction sealant substrate testing.

3. Pre-fabricate as much of the scope in advance of installation so to minimize on-site installation time and potential of conflict(s) with other contractors.

4. Confirm all schedules, intended hours of operation, access routes, equipment handling, noise generation, fume generation, etc. with the Owner's Project Manager prior to commencement of installation.

C. Production and Installation of Interpretive Graphic Elements

1. Graphic work shall conform to the approved samples and shall be applied in precise registration. Include a registration system for the proper positioning of all work under this Section. Work not applied level and true shall be removed and replaced by the Contractor.

2. Do not proceed with any production of graphic files until such time as all samples, mock-ups and other required reviews have been satisfactorily completed to the satisfaction of the Owner, Contract Officer, Architect, and Exhibit Designer.

3. Position all graphics as shown on the drawings and as directed in the field by the Exhibit Designer in the shop of at point of installation.

4. All graphic areas shall be evenly produced and have clear, clean and sharply defined in-focus edges.

5. Graphics shall be shop mounted, unless otherwise approved for field application. All other work shall be applied to surfaces as noted.

6. All installed graphics must be plumb, level, in proper alignment, and securely anchored to support as shown.

7. Included in the scope will be the scanning of any images that will (in final presentation format) exceed 24" in any direction and using original photographs as supplied by the Interpretive Exhibit Designer.

2.4 CLEANING

A. Cleaning methods shall be approved by fabricator and should conform to manufacturer's recommended methods and materials for cleaning.

B. After Installation: Graphics Contractor shall clean soiled surfaces with appropriate, non-toxic cleaners and thoroughly rinse with clean water immediately afterward.

C. Use extreme care to prevent damage to any exhibit surfaces and to adjacent surfaces and materials.

2.5 PROTECTION

A. The Graphics Contractor shall be responsible for protecting their Work from any damage, and repairing to former quality any damage, occurring during the course of the installation.

B. After installation is complete and accepted by the Owner, Contract Officer, Architect, and Exhibit Designer, protection and repair of any further damage shall be the responsibility of the General Contractor.

2.6 INSPECTION AND ACCEPTANCE

A. Test all systems for operational and aesthetic review. Review to be made by the Owner, Contract Officer, Architect, and Exhibit Designer. Correct all deficiencies immediately upon notification.

B. Final inspection and acceptance of completed Graphics Work shall be made by the Owner, Contract Officer, Architect, and Exhibit Designer to verify conformance with plans and specifications.

2.7 SCHEDULE OF GRAPHICS

A. Refer to the Schedule of Graphics located within the EX section of the drawing package.

END OF SECTION

SECTION 11 59 40

MEDIA SOFTWARE

PART 1 - SUMMARY OF WORK

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this Section.

1.2 SUMMARY

A. The Contract Forms, Conditions of this Contract, and Section 11 59 01 applies to the work of this section.

B. The Contractor is expected to be familiar with all other sections of the specifications and drawings as issued for Exhibits and may need to familiar with specification and drawings as issued for Architecture and Engineering

C. Related Sections and Documents

1. Section 11 59 50 – Media Hardware

2. Section 11 59 30 – Interpretive Graphics

1.3 SCOPE OF WORK

A. The Media Software programs include elements of the following general nature:

1. Non-interactive computer software

2. Interactive computer software

3. Interactive computer and projection software

B. The following is an outline of exhibits that require Media Software. See paragraph 2.1 for the narrative description of the media software that corresponds to this outline:

C. The work under this Section consists of further developing, producing and delivering coordinated, and properly formatted media programs for use in public exhibition.

D. Produce professional quality programs based upon written descriptions found within paragraph 2.4 of this specification section.

E. All research, image acquisitions, permission fees, production equipment, studio time, mastering and final format deliverables are part of this contract.

F. Refer to the media hardware documents and other Exhibit documents as a means to better understand the intent of each system and the nature of the software programming that will be employed with each system.

G. Media Software producers are responsible for providing storyboards, draft scripts, shot lists, sample voice narrations, draft musical scores (recorded – not as sheet music) and any other forms documentation that will convey the nature of the work while in preliminary and developmental stages of the project.

1.4 RELATED WORK

A. The Media Hardware systems are to be provided by the Media Hardware Contractor, but the coordination of hardware and software is the responsibility of this contract specifically as it is related to the compatibility of the Media Hardware systems and the Media Software programs. Similarly, it is required that the Media Hardware

Contractor inform the Media Software Producer of all aspects of the systems the are providing to insure that the hardware and software are compatible with one another.

1.5 SUBMITTALS

A. Submittals will include, but is not limited to, program diagrams, data base performance criteria, program storyboards, rough edit footage, sample narration, final edit footage, coordination and confirmation of the compatibility between Media Hardware and Software, and Administrative Submittals.

B. Make submittals in a timely manner as required by the project schedule and relative to Media Hardware scope as indicated in this and related sections of the Specifications.

C. No Work shall be done except from issued Construction Drawings and related Contract Documents, including reviewed submittals, which must be kept at all work locations.

D. Review shall not act to relieve the Media Software Producer from responsibility for content accuracy of the programs and the format compatibility between the software programs and the hardware systems that will deliver these programs. Equipment systems, configurations and format compatibility must be verified prior to the presentation of final edit submittals.

E. Product Data and Written Information

1. Submit product data of all proposed final software elements.

F. Samples

1. Upon the request of the Interpretive Exhibit Designer and Owner's Project Manager and prior to or immediately upon the award of the contract, the Media Software Producer may be required to submit up to three sample interactive computer software, audio and/or video programs that in some way are comparable to the work of this contract as a means to establish a level of quality and character.
    a. Interactive computer software
    b. Projected text and image software

2. Rejected samples shall be resubmitted by the Media Software Producer for approval at no additional cost to the Owner

3. Furnish representative samples of proposed final format software as required by the Exhibit Designer, Media Hardware Contractor, and Owner.

G. Storyboard, Flow Diagram, and Scripts Submittals

1. All programs covered by this work will require storyboards and flow diagrams to aid in the process of advancing the concepts and informing team members.

2. All storyboards and flow diagrams should be produced with copies being submitted to the Owner and Exhibit Designer.

3. All scripts and on-screen text should be produced with copies being submitted to the Owner and Exhibit Designer.

H. Administrative Submittals

1. Description of planning, equipment, production methods, and quality control program.

2. Construction schedule. Coordinate with the general construction schedule per General Requirements.

3. Producer qualifications, as noted below, will be submitted with the bid.

4. Submit reports for all sources of purchased or limited-use still and/or moving image, the contracts for such purchases or uses, and all related information regarding names, addresses, phone, fax, e-mail numbers, itemization of items purchased or permitted, and the dollar amounts of each.

1.6 QUALITY ASSURANCE

A. Qualifications of Media Software Producer:

1. A responsive bid will be by a Media Software Producer, including those above, who meet the following qualifications; evidence of which shall be submitted with the bid.
   a. Established firm with a minimum of five (5) years experience in successfully producing Media Software programs.
   b. The Producer must have had a minimum of five (5) examples of projects of comparable scope to the work of this project.
   c. The Media Software Producer shall submit with their bid, full documentation of their production crew, including producer, director, computer software programmer, cameraman, sound technician, editor, and artist personnel, detailing to the Owner's Project Manager and Exhibit Designer's satisfaction the experience of each person listed, including visual portfolios showing key individuals' prior work, and their ability to perform all phases of the Work. The Exhibit Designer reserves the right to request changes in the Media Software Producer's personnel in order to obtain the highest level of talent available from that organization for this project. Submittal shall also detail physical facilities and established quality control procedures, and a management capability sufficient to produce the required units without causing delay of the project.
   d. The Media Software Producer shall submit a list of four (4) recent, completed productions. The list shall indicate the project name and location, project budget for the Media Software Producer's portion of the Work, the Architect, and the name, address and phone number of the Exhibit Designer.
   e. The Media Software Producer shall provide a standard digital video disc (DVD) proof as references of his/her experience and ability to produce programs comparable to those shown on the drawings and detailed within these specifications. These materials shall be used to evaluate the Media Software Producer's ability and experience to perform this Work, and will be a major consideration in the selection process.

B. Exhibit Designer and Owner's direction regarding Media Software Work:

1. It is intended that the other Media Software Work will be produced in such a manner that all Media programs will be produced outside of the Project Site.

2. It is the Exhibit Designer and Owner's intention to have an active role during all developmental stages of the Media Software Work.

3. To achieve the desired final effects, the Media Software Producer will coordinate and cooperate fully with other Contractors, the Construction Manager, the Exhibit Designer, and the Owner.

4. All Work in this Section shall be performed under the observation and review of the Exhibit Designer and the Owner's Project Manager.

5. The Exhibit Designer and Owner explicitly reserve the right to continuously monitor the work for aesthetic quality and to assume control of the work through direction of the Media Software Producer's producer and/or director until specified effects are achieved.

1.7 STANDARDS

A. Comply with the project specifications and industry standards for all equipment, materials, methods of production, and final deliverable formatted programs. In case of conflict between this section of specifications and the general requirements and conditions of the general contract, the more stringent of two shall govern.

1.8 PROTECTION OF PROPERTY

A. When working on site, exercise all caution to work within the facility and around the Work of other contracts in such a way as to neither disturb that Work, nor cause any damage to existing conditions.

B. When working with any lighting, electrical, or Media Hardware systems, confirm all procedures with the appropriate designers, engineers, or Contractors so to prevent any damage to these systems.

1.9 DELIVERY, HANDLING, AND STORAGE

A. Properly store and protect all original and master copies of sound, still and moving image materials during the course of the Work.

1.10 PROJECT CONDITIONS

A. Examine the lighting, electrical, or Media Hardware systems and related conditions: The installer must examine the conditions under which the work of this Section is to be performed, and notify the Construction Manager of any unsatisfactory conditions. Do not proceed with work under this Section until unsatisfactory conditions have been corrected in a manner acceptable to the Producer.

B. Protect installed work from damage by other trades until Exhibit Designer and Owner's acceptance of work. Advise Owner's Project Manager of required protection procedures.

C. Coordination: Coordinate with other work, and in particular the Media Hardware Contractor, whose work will be directly related to the production of the scope of the contract.

1.11 SEQUENCING, SCHEDULING, AND COORDINATING

A. Prior to commencing installation, arrange a job site meeting to be attended by the Media Software Producer's representative, the Media Hardware Contractor, the Owner, the Exhibit Designer and any other representatives of other trades associated with the work of this Section and related Sections, as determined by the Exhibit Designer and the Owner's Project Manager.

B. The purpose of the meeting shall be to discuss requirements of the Contract Documents, shop drawings, job and equipment readiness and material storage and protection, to assure that details are correct, that materials shall be installed properly, coordination of other trades, and to review all aspects of on-site production, especially as it relates to the production of the Connectedness theme presentation.

C. Following the meeting, prepare a written report containing:

1. Meeting date, names and affiliations of those present.

2. Written statements from each installer and manufacturers' representative of their acceptance of the requirements of the Contract Documents for the use of their material.

D. Do not commence work of this Section unless documents required herein above have had their final review by the Exhibit Designer.

1.12 GUARANTEE

A. Guarantee Work listed in this Section for one year from date of Final Acceptance.

B. Provide two copies of written statement of guarantee, satisfactory to the Exhibit Designer, Architect, and Construction Manager prior to Final Acceptance.

PART 2 - PRODUCTS AND INSTALLATION

2.1 PROGRAM DESCRIPTIONS

A. The Media Software program formats will conform to the equipment that is specified by the Owner and will be prepared in accordance with industry standards relative to the equipment being specified by that section as well as that which is shown by the related drawings.

B. The software programs that are part of this scope of work are as follows:

1. TBD

2. 2 MATERIALS

A. Materials for Programs

1. Coordinate all software programs with the Media Hardware provider in order to assure compatibility of between both.

2. Provide two copies in format compatible with the final, installed Media Hardware system and produced from original master.

3. Provide one original digital format master

2.3 EXECUTION

A. Pre-Production

1. Verify that all Media Software is compatible with the specified and approved hardware systems. If conflicts exist, do not commence production until such conditions have been corrected and the Owner's Project Manager or the Exhibit Designer has granted approval for commencement of production.

2. Verify that all storyboards, scripts, samples, general treatments and all other submittals have been reviewed and approved prior to commencement with production.

3. Review all graphic layout standards, as provided by the Exhibit Designer, and verify that these standards are appropriate and compatible with the software system(s) that are part of this scope of work.

4. Provide a detailed production schedule sufficient to inform the Owner and Exhibit Designer of all key milestones and otherwise sensitive dates for production.

5. Identify key dates when production may occur in any remote locations and/or countries outside of the U.S. with the understanding some combination of the Owner and/or Exhibit Designer may accompany the production team (at their own expense)

6. Identify key dates for reviews and approvals.

B. Production & Post Production

1. Proceed with production upon receipt of necessary approvals

2. Produce media programs using profession-grade equipment and securing all required permissions, fees, and releases for stock and/or original new material.

3. All permissions, fees, and releases for stock or new material should be for unlimited exhibit use by the Owner.

4. Produce graphic layouts based on graphic standards provided by the Exhibit Designer.

5. Produce rough cuts of all elements for purposes of review of work in progress.

6. Produce refine rough cuts based upon Owner and Exhibit Designer's review and approval.

7. Produce 95% final cuts of all media elements for review of details of each. This review to serve as a final review prior to production of final elements.

8. Produce 100% complete media elements for final-final review. This review should not lead to any changes to the media unless previously requested changes were not integrated into the programs.

2.4 INSTALLATION (at shop and in the field)

A. For all technical aspects of the installation work covered by this scope of work:

1. Work in dust-free conditions (or conditions deemed acceptable by industry standards.)

2. Comply with recommendations of manufacturer of products to be installed for proper preparation procedures. Such compliance extends to include the proper use of related equipment not included within this contract, but integrally related such as the MEDIA hardware.

3. Comply with combined printed recommendations of all manufacturers, except where more stringent requirements are indicated.

4. Confirm that all software is compatible with the media hardware that is being provided for this project.

5. Pre-install as media software at the media hardware provider's shop in advance of installation of that equipment in the field in order to minimize on-site installation time, adverse climate conditions, and/or potential of conflict(s) with other contractors.

6. Confirm all schedules, intended hours of operation, access routes, equipment handling, noise generation, etc. with the Owner's Project Manager prior to commencement of installation.

7. Verify that all Media and related elements are installed and satisfactory for the installation. If unsatisfactory conditions exist, do not commence installation until such conditions have been corrected and the Owner's Project Manager or the Exhibit Designer has granted approval for commencement of installation.

8. Protect all work from damage during handling and installation. Remove from Project and dispose of all materials with damage or other imperfections, when installed, either negatively effects the qualities of the exhibit and/or impairs the intended performance and aesthetic appearance of the finished exhibit, or the related Media Hardware.

9. Run all programs using exhibit Media Hardware Systems with the Media Hardware Contractor and Exhibit Designer present so that all systems can be evaluated and corrections made if necessary.

2.5 INSPECTION

A. Test all systems for operational and aesthetic review. Review to be made by the Owner's Project Manager and Exhibit Designer. Correct all deficiencies immediately upon notification.

B. Final inspection and acceptance of completed Media Software Work shall be made by the Owner's Project Manager and the Exhibit Designer to verify conformance with design criteria and specifications.

END OF SECTION

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SECTION 11 59 50

MEDIA HARDWARE

PART 1 - SUMMARY OF WORK

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this Section.

1.2 SUMMARY

A. The Contract Forms, Conditions of this Contract, and Section 11 59 01 applies to the work of this section.

B. General provisions of the Contract include an understanding of, and coordination with, the work by the General Contractor who is contracted by the Owner and will be executing work represented in documents created by the Project Architect.

C. Related Sections

1. Section 11 59 01 – General Requirements for Exhibits

2. Section 11 59 30 – Interpretive Graphics

3. Section 11 59 40 – Media Software

1.3 SCOPE OF WORK

A. Work consists of furnishing all labor, material, equipment and controls for all of the Media systems indicated in the flow diagrams and equipment section of this specification. The objective is to provide fully professional, museum-quality audio-visual systems, completely designed, engineered, installed, tested, accepted and ready to use within the exhibits (as designed) and in the environments indicated by the drawings.

B. Provide detailed wire pull schedule of all interconnecting audio, video and control cabling. Coordinate with the site electricians. Supply and pull all necessary Media cables to accomplish the operational objectives of the exhibit.

C. Types of media hardware systems to be incorporated into the project include:

1. Interactive computer and associated text projection systems

2. Interactive “Conservation Station” computer systems

3. Non-interactive animal ID systems

4. Interactive animal ID systems

5. Interactive “Pledge Station” computer system

6. Staff-operated two-way underwater audio communications system

7. Staff-operated wireless Public Address system.

D. Refer to exhibit drawings for information regarding the hardware equipment list, hardware locations, layouts and operational functions of each exhibit element.

E. Refer to Section 11 59 40 Media Software specification for a description of media programs.

F. Coordination with all exhibit cabinetry, and media software production is required and critical to this scope of work.

1.4 GENERAL INFORMATION

A. All media control equipment under this scope will be housed in ordinary public space, with regards to temperature and humidity conditions. All equipment must be able to operate in this environment without degraded life or performance.

B. The media Contractor will be responsible to verify the existing site conditions and coordinate with the exhibit designer and the general contractor all requirements regarding power, signal conduits and any other building related components that may impact the media components in the portion of the building affected by the scope of work. The Media Contractor will be responsible to notify the electrical contractor of the power and signal conduit requirements. The electrical contractor will provide the Media Software Contractor with power as per the contractor's electrical drawings.

C. Equipment specified and shown in the drawings should provide a working, reliable system. It is the responsibility of the Media Hardware Contractor to evaluate and thoroughly understand the intent and goals of each system. If discrepancies are found in the system, the Media Contractor is ultimately responsible to supply and fabricate a working system to meet the original objective. Equipment not mentioned herein nor shown on drawings may be necessary to meet functional requirements and shall be provided without claim for additional payment.

D. Project conditions include exposure to extreme weather and climate conditions. All equipment and related work of this scope of work should conform to industry standards and manufacturer recommendations for the installation and operation of equipment in such an environment.

E. Delivery and installation will require that all systems (to the degree possible) will be pre-fabricated into their kiosk casework, fully tested and labeled prior to delivery on site..

F. Wherever possible, provide equipment and utilize materials and general practices that will provide energy-efficient systems for the project. Identify any equipment or systems that (in the opinion of the contractor) do not provide operational energy-efficiency for the Client.

1.5 MEDIA CONTRACTOR QUALIFICATIONS

A. The bidding media hardware firm shall have relevant experience in the successful completion of the assembly, fabrication and installation of museum projects similar in scope and magnitude to those specified within this document. The bidder must have Media a minimum of ten years of experience in museum installations and having CTS-D and CTS-I certified staff is a requirement to bid. The bidder must be within a reasonable distance of the site as determined by the Owner.

B. Each bidder shall submit with this bid a listing of the key personnel who will be assigned to this project along with a brief job description and resume of their career related backgrounds and experience. If selected, these key personnel must remain directly involved with the project until completion.

C. If the bidder is to use any subcontractors or freelance personnel, the same background and resumes are required. The selected Media vendor is totally responsible for all work performed by his subcontractors or freelance personnel and must supervise in a manner, which ensures proper communication and coordination at the job site.

D. Sustainable Design Best Practices: Provide written statement outlining the sustainable design program(s) practiced by the fabricator and how those programs (inclusive of sources, equipment selection and energy efficiency) will be utilized for this project**.**

1.6 QUALITY, DESIGN AND RELATED DOCUMENTS

A. Furnish detailed equipment schedule for approval. Furnish manufacturer's catalog cut sheets of each different item specified. Approval of the schedule shall not relieve the Contractor of responsibility for errors or omissions.

B. Drawings pertaining to this bid shall be considered a part of this specification and shall be a part of the bidding documents.

C. Flow drawings are detailed to show design intent and signal flow. It is understood and agreed by the successful vendor, that the work herein described shall be complete in every detail, even though every item required for operations may not be specifically mentioned.

1.7 EQUIPMENT SUBSTITUTIONS

A. Due to the potential nature of change within the media equipment industry over any given period of time, it is reasonable to expect that substitutions may be necessary and even in the best interest of the Owner. Some makes and models of equipment may have become out-of-date or replaced by newer and better technology. As a result, the Media Contractor may deem it appropriate to recommend an equipment substitution. For any equipment substitution to be considered by the Exhibit Designer, Architect and Owner, the following information must be provided and conditions met:

1. Specification sheets of equipment.

2. Advantage to the client for substitution such as cost, features, use, reliability, warranty, etc.

3. Assurance that substituted equipment will physically fit in spaces, which may already be designed or fabricated.

4. Assurance that changes will not affect software already produced or planned to be produced. Control systems work with propriety software, which cannot be changed. If equipment is changed to another manufacturer, the Media Contractor is responsible for any additional cost in reprogramming the control software, and any specialized equipment to accomplish the change. Any changes to the control system(s) must be approved (in writing) by the Exhibit Designer and Owner's Project Manager.

5. The substitution of equipment must be initiated in a timely manner so that the change of specifications does not cause any hardship of other contractors, the Exhibit Designer, or the Owner. If in the event such substitutions do cause hardships to others, the recommended equipment will either be rejected or the financial responsibility to correct any hardships to others will become the responsibility of the Media Hardware Contractor.

6. If in the opinion of the Media Hardware Contractor, the equipment specified for this project appears significantly over-specified or under-specified relative to the application intended, it is required that the Contractor make their opinion know as part of their bid proposal. Indicate those items in question and make recommendations for substitutions (along with a brief justification for the substitution)

1.8 COORDINATION WITH THE SOFTWARE PRODUCER

A. The Media Hardware Contractor will be responsible to contact the selected Media Software Producer(s) to coordinate all details. It is imperative that both parties understand each system, its objective and execution. Some of the items that must be addressed are:

1. Exhibit start-up and shut-down procedures.

2. Who installs the program, software and firmware.

3. Timing issues of show starts, intervals, various language versions, etc.

4. The Media Hardware Contractor will be responsible to program the control system, and any other control device with information and guidance supplied by the Exhibit Designer, Owner and Media Software Contractor(s).

5. The Media Hardware Contractor will be expected to supply any and all specialty computers/software to program the controllers specified.

6. Any other items that will assure a system operating as designed.

1.9 COORDINATION WITH GRAPHIC LAYOUTS AND RELATED EXHIBIT COMPONENTS

A. The Media Hardware Contractor will be responsible to contact the selected Graphic producer(s) to coordinate all details. It is imperative that the Media Hardware be coordinated with the graphics in order to maintain the appearance and layout of the graphics relative to the integration of controls, and other elements that might cause a conflict with the graphic layouts.

B. Identify any conflicts between media hardware and any graphic layouts of related exhibit components immediately and contact those affected by the conflict in order to reach an equitable and functional solution.

1.10 SUBMITTALS

A. Shop drawings and product data

1. Required for approval, prior to fabrication and installation:

a. Block diagrams indicating proposed connections of all equipment and indicating equipment types and model numbers.

b. Layout, equipment rack and cabinets (if applicable).

c. Speaker mounting arrangements.

d. Shop drawings of any unit such as control touch panels, switch panels, loudspeaker enclosures or grilles to be fabricated or modified.

e. Submittals as required by specifications.

f. Catalog data sheets of all manufactured items.

2. Submit complete and at one time. Isolated items will not be considered for approval, except by prior written authorization.

3. Rejected items and items requiring correction must be resubmitted at one time, except by prior written authorization.

B. Operations and Maintenance Data

1. Draft Copies: at time of FINAL ADJUSTMENTS AND ACCEPTANCE TESTS specified in PART 3 - EXECUTION, provide draft copies of all specified diagrams, schedules and manuals for inspection during demonstration and acceptance testing. Submit final copies thereafter. All drawings shall be drawn on a computer aided drafting (CAD) system.

2. Block Diagrams: Simplified single line block diagram showing interconnection of all major equipment components and functional relationships. Diagram shall not illustrate terminal or interconnection cable number designations. The function diagram included with these specifications should be modified to exclude details, transformer type, any as built changes, etc. that is suitable for this purpose. Complete on a single sheet of minimum size 8 1/2 in. x 11 in.

3. As-Built Diagrams: Drawings showing all terminal blocks, connectors, switchers, transformers, equipment components and wires. Label all devices with manufacturer, model number and reference number (i.e. SW15, TB 6), reference numbers shall be consistent across all drawings with no repetitions. On wiring diagrams, label all conductors within cables for insulation color or other identifier. Label all connectors, barrier strips, switches, relay sockets, etc. regarding terminal number. If device does not provide terminal designations, provide key diagram for reference. As a minimum, provide an expanded version of the functional diagrams with cables fanned out at termination points and all labeling as specified above; provide additional drawings where complexity does not permit complete information to be shown legibly on an individual sheet no larger than the project sheet size. The intent of the diagrams is to provide sufficiently clear and complete information that a technician of average skill may efficiently and effectively troubleshoot and service the system, even if unfamiliar with the installation.

4. Control Setting Schedule: Fully document the settings of all nonuser adjustable controls. This includes power amplifier gain controls, equalizer settings, etc.

5. Software: Where an external computer or internal computer with CD drive has been used in programming any computer of the system, provide a CD containing the master program for the control system and all programming, communication, or other software required for reprogramming the system.

6. Complete Instruction and Maintenance Manual: Prepare in the form of an instructional manual for use by client personnel.

    a. Format:
        1. Size: 8 1/2 in. x 11 in., 20 lb., minimum weight white paper for word processing.
        2. Drawings: Provide reinforced punch binder tab, bind in with text. Fold larger drawings to size of text pages. Clear plastic binding tape applied to edge of sheet and then punched is acceptable.
        3. Single sheet product literature and Contractor prepared pages: Provide reinforced punched binder tab. Clear plastic binding tape applied to edge of sheet and then punched is acceptable.
        4. Provide indexed tabs and fly leaf for each separate section. Include printed description of product and major component parts of equipment.

    b. Cover:
        1. Identify each volume with typed or printed title. “MEDIA HARDWARE SYSTEMS OPERATING AND MAINTENANCE INSTRUCTIONS”

    c. Binders:
        1. Commercial quality three ring binders with durable and cleanable plastic covers, 1 in. minimum, 2 in. maximum ring size.
        2. When multiple binders are used, collate the data into related consistent groupings.

    d. Content of Manuals:
        1. Neatly typewritten table of contents for each volume, arranged in systematic order. Identify each product-by-product name and other identifying symbols as set forth in Contract Documents.
        2. Contractor, name of responsible principal, address and telephone number.
        3. Certificate of Warranty.
        4. Service Contract: Include a preliminary schedule for the specified semi annual site visits.
        5. Complete as built diagrams for systems.
        6. Functional diagram.
        7. Original copies of manufacturer’s installation, operation and service manuals, including schematic diagrams for each equipment item.
        8. Shop drawings of all custom fabricated items.
        9. Control setting schedule.

1.11 STANDARDS

A. Comply with the provisions of the following codes, specifications and standards. However, in case of conflict, the more stringent specifications shall take precedence. Notify all necessary parties of any such conflicts immediately so that modifications to other work can be identified and assessed.

1.12 DELIVERY, HANDLING, AND STORAGE

A. Protect materials from extreme temperature, UV exposure, humidity and rain.

B. Carry out all work in a manner that will prevent damage to the structural integrity of the building, the steel exhibit tank, window glazing or other physical features on site. Take extreme care in the handling of materials to prevent overloading of on-grade or hidden structures and to prevent physical damage to surrounding surfaces and waterproofing membranes. Protect surrounding surfaces. Repair all damage to building structure, surfaces, and finishes to original conditions at no increase in contract sum.

C. Delivery and Handling, general: Properly deliver and handle materials to prevent loss or damage to materials. Store materials in dust-proof, weather-tight enclosures to protect against dampness and contamination. Prevent against loss of equipment.

D. Secure in lockable containers all pieces of equipment and related materials against theft and damage while on site and during the installation period in general. All equipment and materials are the responsibility of the Media Hardware Contractor until such time as the Owner has approved the components in their final installed, secured, and operational state.

1.13 PROJECT CONDITIONS

A. Examination of the exhibit space and related conditions: The installer must examine the conditions under which the work under this Section is to be performed, and notify the Construction Manager of any unsatisfactory conditions. Do not proceed with work under this Section until unsatisfactory conditions have been corrected in a manner acceptable to the installer.

B. Protect installed work from damage by other trades until Exhibit Designer and Owner's acceptance of work. Advise Owner's Project Manager of required protection procedures.

C. Coordination: Coordinate with other work, contractors and subcontractors for whose work will be affected by the Media Hardware scope. Coordinate with Owner's Project Manager.

D. Project conditions include exposure to extreme weather and climate conditions. All equipment and related work of this scope of work should conform to industry standards and manufacturer recommendations for the installation and operation of equipment in such an environment.

1.14 SEQUENCING, SCHEDULING, AND COORDINATING

A. Prior to commencing installation, arrange a job site meeting to be attended by the Media Hardware Contractor's representative, the Owner, the Exhibit Designer, the Owner's Project Manager and the representatives of other trades associated with the work of this Section and related Sections.

B. The purpose of the meeting shall be to discuss requirements of the Contract Documents, shop drawings, job and surface readiness and material storage and protection, to assure that details are correct, that materials shall be installed properly, and coordination of other trades.

C. Following the meeting, prepare a written report containing:

1. Meeting date, names and affiliations of those present.

2. Written statements from each installer and manufacturers' representative of their acceptance of the requirements of the Contract Documents for the use of their material.

D. Do not commence work of this Section unless documents required herein above have Media had their final review by the Exhibit Designer.

PART 2- PRODUCTS

2.1 GENERAL PRODUCTS

A. Equipment specified in this document is correct at the time of design. By the actual time of actual execution of this work, it is possible that some products will have been modified, improved, or replaced by various manufacturers. It is the Media Hardware Contractor's responsibility to advise the Construction Manager, the Interpretive Exhibit Designer and the Owner of make or model changes and follow the procedures for product substitution in Section 1.07.

2.2 PRICING

A. In preparing the bid, each item should be priced in such as manner as to indicate the cost of all elements required for a functioning media hardware system on a per exhibit basis.

B. It is understood that there are elements that are common to a thematic area and therefore do not apply to a single exhibit. These items should be listed as "common equipment," with all actual items indicated and priced. Include all miscellaneous cables, hardware, racks, etc. required to interconnect the system with all systems and the Media control room. Hardware is to include all hardware items necessary to make a complete working system.

2.3 EQUIPMENT LIST BY EXHIBIT

A. The media equipment list is included within the EX section of the drawing set.

B. Standard commercial-grade equipment racks are to be included.

PART 3 – EXECUTION

3.1 SITE EXECUTION

A. The Media Hardware Contractor shall verify that surfaces, internal wall blocking and ceiling construction are ready to receive work and opening dimensions are as indicated on shop drawings.

B. The Media Hardware Contractor will review all necessary project documents in order to confirm that the work by others is properly accounted for and does not represent any gaps in the scope necessary for the successful execution and completion of this work.

C. The Media Hardware Contractor shall verify that site electrical services are completed and ready for tie-in.

D. Beginning of installation means acceptance of existing conditions and surfaces.

E. It shall be the responsibility of the Media Hardware Contractor to cooperate with all appropriate parties in order to achieve well-coordinated progress and satisfactory final results. He shall watch for conflicts with work of other Contractors on the job and execute moderate moves or changes as are necessary to accommodate other equipment or preserve symmetry or pleasing appearance.

3.2 INSTALLATION

A. Pre-install as many elements as is practical and possible to minimize on-site installation of equipment.

B. Installation includes delivery to the site, terminating all Media connectors and receptacles, necessary hardware, interconnecting components to make a complete working system, using industry accepted standards and quality workmanship.

C. All AC power devices must be properly grounded in accordance with electrical codes. AC power receptacles should be checked for proper ground and wiring prior to installation.

D. The Media Hardware Contractor is responsible for supplying all Media cabling and installing the cabling through the conduits and junction boxes supplied by the Electrical Contractor. Conduits are shown on the attached drawings. The Media Contractor should review all conduits and junction boxes to assure that adjacent conduit sizes and quantities exist for all Media systems. Any discrepancies should be coordinated with the Electrical Contractor prior to pulling cables. Notify the Construction Manager and Interpretive Exhibit Designer immediately upon identifying any conflicts, omissions or other deficiencies that impact the execution of this work.

E. Once all components are in place, the Media Hardware Contractor will optimize system performance by final adjustments and testing of all components. At the completion, the Media Hardware Contractor will demonstrate the performance and capability to the client for their acceptance of the systems. All tests and measurements shall be performed by the Media Hardware Contractor.

F. The Contractor is responsible for all permits and will to adhere to all governing local laws and codes, including Underwriters Laboratories (UL).

G. Review all work with all adjacent scopes of work (such as casework, media software, graphics, etc) to insure that work is coordinated and compatible.

H. All field cable is to be plenum rated and acceptable to local jurisdiction. All cables, regardless of length, shall be marked with printed (no write-on labels will be accepted) wrap-around numbers and shrink-wrap at both ends. There shall be no unmarked cables at any place in the system. Marking codes used on cables shall correspond to codes shown on drawings, run sheets, and patch panels. All inter-rack cabling shall be neatly strapped, dressed, and adequately supported. Terminal blocks and connectors shall be furnished for all cables that interface with racks, cabinets, consoles, or equipment modules. There shall be no inline splices in any cable; all cables are to have service loop. All umbilical cords that will be disconnected often shall be neatly dressed, and protected with a flex harness.

I. As a general practice, on the left side of the rack as viewed from the rear, group in separate harnesses with approximately three inches between each harness: AC power connection; Loudspeaker and high level wiring; Control cables RS-232,RS-422,RS-485,IR, and Relay. On the right side of the rack as viewed from the rear, group in separate harnesses with approximately three inches between each harness: Line level audio cables; Video base band cables; Broadband RF video cables; Ethernet and Fiber Optic Cables.

J. All cables (except video cables, which must be cut to an identical length) shall be cut to the length dictated by the run. For equipment mounted in racks, drawers, or on slides, the interconnecting cables shall be provided with a service loop of appropriate length. No cable shall be installed with a bend radius less than that recommended by the cable manufacturer.

K. All cables (except video cables, which must be cut to an identical length) shall be cut to the length dictated by the run. For equipment mounted in racks, drawers, or on slides, the interconnecting cables shall be provided with a service loop of appropriate length. No cable shall be installed with a bend radius less than that recommended by the cable manufacturer.

L. All wires and cables used in assembling custom panels and equipment racks shall be formed into harnesses which are tied and supported in accordance with accepted engineering practice.

M. Harnessed cables shall be combed straight. Harnesses with intertwined members will be deemed unacceptable. Each cable that breaks out from a harness for termination will be neatly tie wrapped. Harnessed cables shall be found in either a vertical or horizontal relationship to equipment, controls, components or terminations.

N. All system components and related wiring shall be located with due regard for the minimization of induced electromagnetic and electrostatic noise, for the minimization of wiring length, for proper ventilation, and to provide reasonable safety and convenience for the operator.

O. All drain wires will be covered in a sleeve. Over each end of wire, the heat shrink should be a minimum of 1" and shall be brought up against the connector.

P. All equipment racks shall be labeled with the Contractor's full contact information and the date of warranty start and end dates.

3.3 CONNECTION PLATE RECEPTACLES

A. Unless otherwise detailed herein, the following types of panel receptacles (as required) shall be used on all connection boxes, panels, plates, and wire ways:

1. Audio (-10 dBm unbalanced Isolated solder RCA pin type)

2. Audio (microphone or balanced line Audio +4 level - XLR type)

3. Audio (loudspeaker level) – Speak-on connector. Jack shall be insulated from panel type.

4. Video – BNC Receptacles shall be insulated from panel type.

5. RF video - F type connector insulated from panel type

6. Patch Panel Assignments - All patch panels shall be wired so that signal "sources" (outputs from) appear on the upper row of a row pair, and all "loads" (inputs to) appear on the lower row of a row pair.

3.4 PATCH PANEL DESIGNATIONS

A. All patch panels shall be permanently labeled with legible lettering. The designations shall be by the recognized generic name of the equipment device. Horizontal row numbers and vertical patch point must also label each patch panel. Identification of each patch point shall be included on the as-built drawings, as well as on reproductions of these drawings, which shall be mounted in an appropriate location near the equipment racks.

3.5 GROUNDING PROCEDURES

A. In order to minimize problems resulting from improper grounding, and to achieve maximum signal-to-noise ratios, the following grounding procedures shall be adhered to:

1. System Grounds: A single primary "system ground" shall be established for the systems in each particular area. All grounding conductors in that area shall connect to this primary system ground. The system ground shall be provided in the audio equipment rack for the area.

2. The contractor is responsible to insure that the power is on the same electrical phase for all audiovisual equipment, and that a technical ground has been provided. The contractor shall be responsible for determining if the metallic conduit is properly electrically bonded to the building ground system.

3. Under no condition shall the AC neutral conductor, either in the power panel or in a receptacle outlet, be used for a system ground.

4. Verify resistance is less than 1 Ohm from ground buss bar to the chassis of each rack-mounted component. Verify less than 1 Ohm from ground buss bar to audio ground terminal of each rack mounted component's input and output connector.

5. Audio Cable Shields: All audio cable shields shall be grounded at one point only. There are no exceptions. For inter- and intra-rack wiring, this requires that the shield be connected at one end only.

6. Video Receptacles: All video receptacles that are provided and installed by the AV Contractor shall be ground insulated from the mounting panel, outlet box, or wire way. Unless otherwise detailed herein, this shall be accomplished by using insulated-from-panel type receptacles. Video cable and connectors shall be 75 Ohm.

3.6 PERFORMANCE STANDARDS

A. Unless restricted by the published specifications of a particular piece of equipment, or unless otherwise required under the Detailed Specifications, the following performance standards shall be met by each system:

1. Audio:

S/N (including crosstalk and hum)	65 dBm minimum
Total Harmonic Distortion	1% maximum from 30Hz to 15,000 Hz
Frequency Response	– within plus or minus 3.0dB, 30Hz to 15,000 Hz
Hum and noise level	at least 70dB below power amplifier output from 20-20khz

2. Composite Video (signal):

S/N (peak to RMS)	– Less than or equal to 50dB unweighted DC to 70MHz
Crosstalk, unweighted DC to 4.2mHz	– 45dB minimum
Frequency Response	– Within plus or minus 0.5dB to 3.58MHz for NTSC
Line and Field Tilt	– 2% maximum
Differential Gain	– 2% maximum
Differential Phase	– 3 degrees maximum
Signal Gain	1 into 75ohm terminated

3. Video (timing):

System timing	Within 2 degrees at 3.58Mhz
Color timing	Within 2 degrees at 3.58mHz
Minimum desired RGBHV signal bandwidth at display device inputs	– 300 MHz (-3 dB)
RGBHV, YC signal timing	Within 1 nanoseconds between channels

Maximum RGBS cable attenuation	– 300 MHz bandwidth signal at 100 feet (-3dB)
Frequency response for RGBHV	– plus/minus 0.5dB to 70Mhz

All RGBHV signal interfaces to be provided with adjustable peaking controls to reduce cable attenuation losses.

4. RF Systems:

Carrier to noise ratio	> or = to 45dB
Hum and Low frequency disturbance	< or = to.75% peak to peak
Final tab level	– > from 5dBmv to 10dBmv

3.7 CLEANING

A. Cleaning methods shall be recommended to the Owner and Exhibit Designer by the Media Hardware Contractor.

B. After Installation: Media Hardware Contractor shall clean soiled surfaces with appropriate, non-toxic cleaners and thoroughly rinse with clean water immediately afterward.

C. Use extreme care to prevent damage to any exhibit or building surfaces and to adjacent materials.

3.8 PROTECTION

A. The Media Hardware Contractor shall be responsible for protecting their Work from any damage, and repairing to former quality any damage, occurring during the course of the installation.

B. While engaged in the installation of Media Hardware elements, the Contractor will handle and store materials and equipment in such a manner that will prevent loss or damage to these materials and equipment. Store materials in dust-proof, weather-tight enclosures to protect against dampness and contamination.

C. Secure in lockable containers all pieces of equipment and related materials against theft and damage while on site and during the installation period in general. All equipment and materials are the responsibility of the Media Hardware Contractor until such time as the Owner has approved the components in their final installed, secured, and operational state.

D. After installation is complete and accepted by the Owner's Project Manager and Exhibit Designer, protection and repair of any further damage and/or theft shall be the responsibility of the Media Hardware Contractor.

3.9 FINAL ADJUSTMENTS AND SYSTEM ACCEPTANCE TESTS

A. System acceptance tests will not be performed until the Media Hardware Contractor's system checkout has been completed. The system acceptance tests will be supervised by the Owner and their representatives. They will consist of the following:

1. A physical inventory will be taken of all equipment on-site and will be compared with equipment lists in the contract documents.

2. The Media Hardware Contractor shall coordinate this time with the Owner and their representatives so that the room is available for testing. The Owner shall provide free access to all areas, lighting and electrical power as needed. If this testing involves working other than normal hours, it will be accomplished without claim for extra payment.

3. The Media Hardware Contractor is responsible for ensuring that the area in which his work has been performed is completed according to his contract and is in a clean and orderly condition, ready for acceptance.

4. The Media Hardware Contractor shall be prepared to verify the performance of any portions of the system by demonstration.

5. The Media Hardware Contractor shall make additional mechanical and electrical adjustments within the scope of work that are deemed necessary by the Owner and their representatives.

6. In the event further adjustments are required, or defective equipment must be repaired or replaced, tests may be suspended or continued at the discretion of the Owner's Project Manager and/or Exhibit Designer.

7. Three sets of all final "as-built" drawings, run sheets, manuals and other required documents shall be delivered to the Owner and their representatives prior to the scheduling of acceptance tests. One complete set of these documents shall be on hand at the time of testing.

8. The Media Hardware Contractor's personnel performing these tests are to be thoroughly familiar with all details of the system. The tests team is to include the Field Supervisor and Project Engineer who were in charge during the course of the installation work.

9. Test all systems for operational and aesthetic review. Review to be made by the Owner's Project Manager and Exhibit Designer. Correct all deficiencies immediately upon notification.

10. Final inspection and acceptance of completed Media Hardware Work shall be made by the Owner's Project Manager and the Exhibit Designer to verify conformance with design criteria and specifications.

3.10 TRAINING

A. The Media Hardware Contractor will provide complete and comprehensive system training to designated personnel in the proper operation, maintenance and service techniques of the Media systems to achieve optimum performance and utilization. Budgeted time for this activity should be a minimum of 8 hours. Some training usually takes place during final installation, if the user is available.

B. Training will take place immediately following installation, and will be conducted at a time that is mutually satisfactory to the Client's staff as well as the Media Hardware Contractor. Advance notice of not less than 2 weeks shall be given for all training sessions.

3.11 SERVICE AND WARRANTIES

A. All equipment will be new and carry manufacturer's full warranties that will be handled by the Media Hardware Contractor during the first year of operation. In addition, the Media Hardware Contractor will guarantee the entire system as assembled for one year from date of acceptance. During that time, equipment or system problems will be repaired or replacements made at no charge. The Media Hardware Contractor should maintain a 24-hour technical emergency phone service for a period not to exceed 12 months after which time, the Media Hardware Contractor will provide assistance within the framework of their normal daily work schedule. A duplicate set of the system documentation is to be maintained at the Media Hardware Contractor's office to assist in telephone troubleshooting.

B. Local Service: If the Media Hardware Contractor is located too great a distance form the site to promptly service the installation, an arrangement will be made with a local Media service organization who will be engaged and trained by the Media Hardware Contractor to perform local on-site service. Two routine service/maintenance calls by one technician are required during the first year warranty. The local service organization must be capable of performing all on-site requirements and be responsive within 24 hours. The Media Hardware Contractor is ultimately responsible for all service and warranty issues during the warranty period, regardless of the local firm's performance.

C. All materials contained in this specification should come with complete manufacturers' warranties against defects in parts and workmanship. A copy of all available manufacturers' warranties will be included in the user's manual.

D. The Media Hardware Contractor warrants the systems it supplies and installs to be free of defects in parts and workmanship for a period of one year. If during that time the system fails to perform as specified, the Media Hardware Contractor will correct the problem at no additional charge.

E. It is understood that additional charges will be made for the repair or replacement of any piece of equipment that fails due to abuse, carelessness, mishandling, use of a product in an application other than that intended, and attempted repairs performed by anyone other than the Media Hardware Contractor. It is also understood that any problems related to software are to be handled by the Media Software Producer.

3.12 EXHIBIT EQUIPMENT

A. Refer to drawings for equipment list and system flow diagrams.

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SECTION 11 59 70

EXHIBIT FURNITURE & CASEWORK

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this Section.

1.2 SUMMARY

A. The Contract Forms, Conditions of this Contract, and Section 11 59 01 applies to the work of this section.

B. The Contractor is expected to be familiar with all other sections of the specifications and drawings as issued for Exhibits and may need to familiar with specification and drawings as issued for Architecture and Engineering.

C. Related specification sections

1. 05 04 00 Metal Work

2. 11 59 01 General Requirements for Exhibits

3. 11 59 03 Interpretive Graphics

4. 11 59 50 Media Hardware

1.3 SUMMARY OF WORK

A. The scope of work includes:

1. Structures and/or backing material for all graphic and interpretive elements

2. Structures intended to house interpretive and/or mechanical interactive elements (exclusive of graphics, media hardware, and media software which are specified separately).

3. Miscellaneous fabrications, hardware and related elements to support interpretive exhibits

B. General provisions of the Contract include an understanding of, and coordination with, the work by the Construction Manager who is separately contracted by the Owner and will be executing work represented in documents created by the Architect.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's data completely describing products.

B. Shop Drawings: Submit shop drawings showing details of construction and methods of attachment to adjacent Work.

C. Samples: Wood, metal, and plastic fabrications, non-reflective glass, and paint samples in small quantities as may be requested for review and trial application of materials and finishes.

1. Samples of all materials and finishes to be incorporated into the finished work of this project

D. Pre-installation Mock-up Review: Assemble selected exhibit elements for pre-installation review by Owner, Construction Manager, Architect and Exhibit Designer

1.5 QUALITY ASSURANCE

A. Qualifications

1. Fabricator: Equipped for and experienced in doing Work equal to standards specified and be able to provide evidence of such experience to the Owner, Construction Manager, Architect, and Exhibit Designer's satisfaction.

B. Sustainable Design Best Practices

1. Provide written statement outlining the sustainable design program(s) practiced by the fabricator and how those programs (inclusive of sources, materials and fabrication) will be utilized for this project.

1.6 DELIVERY, STORAGE AND HANDLING

A. Storage and Protection:

1. Deliver casework to job site only after proper facilities are available for handling, storing and protecting items; receiving areas are broom cleaned; exterior openings are closed up; wet Work and mechanical and electrical rough-ins are completed.

2. Provide temporary protective covers for items during delivery, installation and until final acceptance of the Project.

1.7 PROJECT CONDITIONS

A. Environmental Requirements: Maintain equilibrium moisture content in wood until job is completed; maximum relative humidity 50 percent to 65 percent at 70 degrees Fahrenheit.

B. During transit from Contractor's place of work to the project site, prevent humidity from causing any undesired effects upon the work of this scope

C. Project site conditions include high levels of: temperature; humidity; UV exposure; and wind. All factors must be accounted for when finalizing the materials, finishes, and details related to the scope of this project.

1.8 SEQUENCING AND SCHEDULING

A. Provide Construction Manager with all information regarding sequencing and scheduling of pre-construction, construction, delivery and installation on site, as well as any critical sequences that involve the work of others.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General – Lumber

1. Lumber and Plywood: Kiln-dried to equilibrium moisture content suitable for fabrication in shop and suitable for use intended; minimum 8 percent, maximum 12 percent.

2. Furnish lumber sanded 4 sides unless otherwise noted.

3. Identification: All lumber shall have grade stamp of governing grading agency. Lumber not stamped or of wrong grade will be rejected.

4. Flame Spread: Class II.

5. Flame Spread Index 25-75.

B. Lumber Material (for interior use only unless approved by the Owner)

1. MDX Plywood 3/4" paper finish on two sides (MDO not allowed)

2. Hardwood Veneer Edging 3/4" for all exposed plywood edges

C. Metal Fabrications:

1. Aluminum sheet stock

2. Aluminum angle stock

3. Galvanized steel angle stock

4. Galvanized steel tube stock

5. Water resistant and non-corrosive hardware as required

D. Hardware, Locks and Fasteners: hardware, hinges, locks, nails, screws and other devices of type, size, material and finish required for application indicated to provide operable, lockage, and secure attachments, visually concealed where possible. Avoid adhesive fasteners that will not be able to withstand humid conditions and the potential for swelling and contraction of wood products

1. For all exhibit casework, provide non-corrosive, exterior grade fasteners and anchors using #316 stainless steel and/or aluminum preferred.

E. Paint:

1. For all wood construction, use Benjamin Moore, Sherwin Williams, Cabot brand or equivalent paint or stain applied according to manufacturer's recommendations and industry standards.
   a. Exterior satin finish acrylic paint on selected interior elements
   b. Exterior stain brush applied and rag rubbed for antiqued, stressed effect on selected exterior elements

2. For all aluminum (or other metal) construction, use catalyzed polyurethane enamel or powder coated paint products that are masked and painted onto all visible surfaces.
   a. Sherwin Williams Powdura Super Durable TGIC Powder Coating products or equivalent
   b. Sherwin Williams Waterbased Acroloon 100 Polyurethane, or equivalent VOC compliant water based polyurethane product.
   c. Fabricator-recommended products to be used only upon approval

3. Surfaces to be painted should match all color listed on the drawings. In the event clarification is required, contact the Interpretive Exhibit Designer for additional information.

4. Use water base clear coat products and avoid use of solvents and airborne products wherever possible and appropriate. Airborne products, when used must be applied with the appropriate level of ventilation and filtration.

F. Acrylic:

1. Lexan non-glare acrylic 1/8" to 1/4" thickness as required per application.

2. Maximum allowable deflection: 1/32" over 1'-0"

3. Museum quality material with durable, (as scratch-resistant as possible) finish required.

4. All joints and visible edges to be polished and bonded without inclusions, bubbles or other unwanted blemishes

G. Electronic Components and Electrical Coordination

1. Miscellaneous hardware, wire and connectors for all internal electrical requirements of each exhibit
   a. Base-building power, conduit and junction boxes provided by the Construction Manager

2. All equipment and materials to be UL approved and to meet with local fire and safety codes

3. Coordinate with Media Hardware Contractor to ensure the size of openings in exhibit casework, mounting holes, ventilation and any wire-chase areas are compatible with the equipment the Media Hardware Contractor will be providing.

4. Coordinate final details of size, materials, and appearance of each element with graphic layouts to insure compatibility. Identify any conflicts immediately so that equitable solutions can be obtained

I. Miscellaneous Hardware and Controls:

1. Use high-quality, non-corrosive hardware in all exterior applications. For interior applications, use museum quality hardware for all elements.

2. Controls such as push buttons, joy sticks, spin browsers, etc. must be commercial, exterior grade

3. Coordinate final details of size, materials, and appearance of each element with graphic layouts to insure compatibility. Identify any conflicts immediately so that equitable solutions can be obtained

2.1 FINISHES

A. Shop Finishing

1. Back Priming of Wood: Back prime all concealed surfaces of lumber.

2. Visible-Side Wood Priming: Prime all surfaces with appropriate sealers and primers prior to application of final finishes

3. Visible-side Wood Finishing: Finish all surfaces as noted by drawings. All paint or graphic materials to be used as finishes will be applied according to manufacturer's recommended procedures and in accordance with industry standards.

4. Finish Painting: For opaque and transparent finish. Touch up painting on site. No visible brush marks, drips or alteration to finish texture and sheen permitted

5. Coat all aluminum framework assemblies and structures with powder coat paint finishes or polyurethane.

6. Finish all visible surfaces as noted on drawings, and when information on drawings is lacking detail, contact the Interpretive Exhibit Designer for more specific instructions. The lack of notation on drawings does not relieve the Contractor from providing finishes to all visible surfaces.

B. Field Finishing

1. Preparation For Final Finishing
   a. Set exposed fasteners. Apply putty in exposed fastener indentations. Sand wood fabrication work smooth. Apply specified finish over finished putty work so to leave no noticeable dimple or pimples.

C. Visible Hardware:

1. US 32, satin finish chrome or approved equivalent

2. 316 Stainless steel

PART 3 - EXECUTION

3.1 EXAMINATION OF CONDITIONS

A. Examine architectural surfaces scheduled to receive exhibit casework for conditions that will adversely affect installation.

B. Do not install work until unsatisfactory conditions have been corrected.

3.2 FABRICATION, DELIVERY AND INSTALLATION

A. Preparation

1. Verify measurements at job site.

2. Verify details and dimensions of fixtures integral with exhibit cabinetry for proper fit and accurate alignment.

3. Coordinate all work with adjacent scopes of work on site and in particular, that scope which is directly connected with the scope of this work.

4. All work to be based upon approved samples, data sheets, shop drawings and other required documents.

5. No fabrication will be allowed without full and proper approvals having been secured in a timely manner.

B. General Fabrication Requirements.

1. Factory-fabricate and assemble Work in complete units insofar as dimensions permit shipment and installation.

2. Kerf backs of solid members more than 5 inches wide or more than 1 inch nominal thickness.

3. Conceal all general hardware, fasteners, hinges, mounts, and other undesirable details from visitor's view

4. All fabrication requires complete approval from Owner, Exhibit Designer and Construction Manager before commencement.

5. No fabrication will be allowed without required approvals and authorization by the Construction Manager and Exhibit Designer

6. Set work square, level, plumb with edges scribed, accurately and secure in place with fastenings, clips, braces, brackets, anchors, shims and blocks.

7. Conceal all fasteners, weld joints, seams, etc. where possible and set nail heads for putty in exposed portion and conceal screws as indicated.

8. Miter inside and outside corners of running trim; bevel end joints together.

9. Touch-up and repair all finish surfaces that become marked or damaged during the installation of this work.

C. Delivery

1. Coordinate and schedule all details of delivery with Construction Manager

2. No delivery of materials or fabricated units will be accepted without approval from the Construction Manager.

3. Provide Interpretive Exhibit Designer with minimum of 2 weeks advance notice prior to making any deliveries to the site

D. General Wood Surfaces

1. Thoroughly hand sand. Take care that cross sanding is removed by final sanding in direction of grain; ease “knife-edge” corners and edges by sanding.

2. Free of dust, glue, stains, and other foreign matter and in proper condition to receive finish.

3. Apply clear sealer over dyed wood in accordance with manufacturer’s instructions.

E. General Metal Surfaces

1. Shop-finish all metal surfaces to the extent possible.
   a. Finish all assembly after fabrication with powder coat paint or catalyzed polyurethane enamel.

2. Protect all visible finished surfaces from damage.

3. Touch up all defects that occur during installation using the same methods of application used in original finish of these surfaces.

F. Graphic Elements

1. Confirm all graphic sizes for each unit and review to assure that all interactive, media, or other non-graphic elements are correct.

2. Confirm locations for exterior graphic elements prior to installing work

3. Confirm that all power and data systems are adequate and appropriate for the work of this scope. Construction to assure weather-tight fit between graphic railings and structural base elements.

4. Provide for all connections to base-building power (brought to each graphic railing location by others) and provide all UL rated labels as required by code.

5. Shim all graphic railings as necessary so that all graphic railings stand plumb and true

6. Confirm that all elements will be sufficient to meet the design criteria for this project and to hold up to visitor impact upon units

7. Secure (structurally) all elements sufficient to meet the design criteria for this project and to hold up to visitor impact upon units

G. Interpretive and Interactive Exhibit Structures

1. All elements to be well secured.

2. Coordinate to assure secure attachment to floor and/or wall

3. Coordinate for all connections to base-building power, HVAC, and other architectural elements (brought to each overhead graphic railing location by others) and do so with qualified, licensed electrician

4. Provide all necessary backing material and supports

5. All hinges to be concealed.

6. No visible means of support or anchoring unless otherwise detailed by the Exhibit Designer.

H. Free-standing Interpretive Exhibits

1. Coordinate all power and data conduit (brought to each location by others) and do so with qualified, licensed electrician

2. Coordinate with Media Hardware contractor and other trades as required

I. Wall-mounted photo-mural exhibit elements

1. Confirm all locations prior to delivery and installation

2. Before installation, confirm that surface (by others) is suitable for installation.

3. Coordinate all final installation with the Interpretive Exhibit Graphics layouts prior to making any permanent attachments

J. Electronic components and Electrical coordination

1. Secure all connections to base-building power (brought to each exhibit location by Construction Manager) and do so with qualified, licensed electrician.

2. Have all work checked by project electrical contractor for compliance with their work and all applicable codes.

3. Coordinate all electrical work with graphics.

4. Secure all connections to base-building power (brought to location by others)

3.3 ADJUSTING AND CLEANING

A. Remove damaged or otherwise disfigured portions and replace with new materials prior to the Owner's acceptance.

3.4 PROTECTION

A. Protect all installed work from damage until accepted by the Exhibit Designer, Architect and the Construction Manager.

3.5 FINAL ADJUSTMENTS AND ACCEPTANCE

A. Conduct final review and secure acceptance approvals:

1. A physical inventory will be taken of all items that comprise this scope of work

2. The Exhibit Casework Contractor shall coordinate a punch-list review of all items and to do so with the Construction Manager, Owner, and Exhibit Designer present.

3. The Exhibit Casework Contractor is responsible for ensuring that the area in which his work has been performed is completed according to his contract and is in a clean and orderly condition, ready for acceptance.

4. The Exhibit Casework Contractor shall be prepared to verify the performance of any portions of the system by demonstration.

5. The Exhibit Casework Contractor shall make additional mechanical and electrical adjustments within the scope of work that are deemed necessary by the Owner and their representatives.

6. In the event further adjustments are required, or defective equipment must be repaired or replaced, tests may be suspended or continued at the discretion of the Owner's Project Manager and/or Exhibit Designer.

7. Three sets of all final "as-built" drawings, manuals, and other required documents shall be delivered to the Owner and their representatives prior to the scheduling of acceptance review.

8. The Exhibit Casework Contractor's personnel performing these tests are to be thoroughly familiar with all details of the exhibits.

9. Review all elements for operational and aesthetic quality. Review to be made by the Owner's Project Manager and Exhibit Designer. Correct all deficiencies immediately upon notification.

10. Final inspection and acceptance of completed work shall be made by the Owner's Project Manager and the Exhibit Designer to verify conformance with design criteria and specifications.

3.6 TRAINING

A. The Exhibit Casework Contractor will provide complete and comprehensive training to designated personnel in the proper operation, maintenance and service techniques of applicable elements that comprise this scope or work. Budgeted time for this activity should be a minimum of 4 hours. Some training usually takes place during final installation, if the user is available. Training will take place immediately following installation.

3.7 SERVICE AND WARRANTIES

A. All equipment will be new and carry manufacturer's full warranties that will be handled by the Media Hardware Contractor during the first year of operation. In addition, the Exhibit Casework Contractor will guarantee the each element as assembled for one year from date of acceptance. During that time, equipment or materials problems will be repaired or replacements made at no charge.

B. All materials contained in this specification should come with complete manufacturers' warranties against defects in materials, parts and workmanship. A copy of all available manufacturers' warranties will be included in the user's manual.

C. The Exhibit Casework Contractor warrants the elements it supplies and installs to be free of defects in parts and workmanship for a period of one year. If during that time any elements fail to perform as specified, the Exhibit Casework Contractor will correct the problem at no additional charge.

E. It is understood that additional charges will be made for the repair or replacement of any piece of equipment that fails due to abuse, carelessness, mishandling, use of a product in an application other than that intended, and attempted repairs performed by anyone other than the Exhibit Casework Contractor.

END OF SECTION

SECTION 133423 - FABRICATED STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes design and engineering of factory-assembled modular buildings.

1. Engineer stamped prints for structural approval.
2. Manufacturing of modular buildings.
3. Transporting the buildings to the sites on a flatbed trailer prefabricated steel control booths.

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Meet the requirements listed on the Appendix B document in the contract drawings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For factory-applied color finishes.

D. Delegated-Design Submittal: To comply with performance requirements and design criteria, including analysis data signed and sealed with a valid North Carolina seal of a qualified professional engineer responsible for their preparation. The buildings shall have a medallion affixed to each that demonstrates it is acceptable to the State of North Carolina.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.3, "Structural Welding Code - Sheet Steel."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Safety Glazing Products: Category II materials complying with testing requirements in 16 CFR 1201.

D. Preinstallation Conference: Conduct conference at **Project site**.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair finish or replace wall panels that fail in materials or workmanship within specified warranty period.

1. Warranty Period: **Five** years from date of Acceptance by the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum: Alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated, and as follows:

1. Extruded Shapes: ASTM B 221 (ASTM B 221M).
2. Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T4 or Alloy 6061-T6.

B. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, commercial quality, G90 (Z275) coating designation; mill phosphatized.

C. Galvanized, Rolled Steel Tread Plate: ASTM A 786/A 786M, rolled from steel plate complying with ASTM A 572/A 572M, Grade 55 (380); hot-dip galvanized according to ASTM A 123/A 123M.

D. Steel Structural Tubing: ASTM A 500, Grade B.

E. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

F. Steel Mechanical Tubing: ASTM A 513, welded steel mechanical tubing.

G. Zinc-Coated (Galvanized) Steel: Hot-dip galvanized according to ASTM A 123/A 123M.

H. Stainless-Steel Sheet: ASTM A 666, Type 304.

I. Plywood: DOC PS 1, Exterior grade.

J. Particleboard: ANSI A208.1, Grade M-2.

K. Roofing: thermoplastic single ply pvc roof system (includes 6" white termination bar & fasteners).

1. Sloped foam 1/4" start; 1/4" slope per foot.
2. Sloped foam barrier slipsheet
3. Roof panels: panels- 4-inch-thick wall and ceiling panels - cam lock mechanism for panel assembly - high density extruded polystyrene foam laminated between sheets of 26-gauge galvanized steel - 2.4 lbs weight per square foot of panel surface - r 32 insulation factor - tan exterior/white interior stucco embossed finish.

L. Floor/Base: 4-inch-thick floor panels - cam lock mechanism for panel assembly.

1. High density extruded polystyrene foam laminated between sheets of: exterior 26 gauge Lightstone steel; interior 26-gauge galvalume steel - 1/2" plywood reinforcement - 3.5 lbs. weight per square foot of panel surface - r 28 insulation factor.
2. Exterior stucco embossed Lightstone 26 gauge - interior stucco embossed galvalume 26 gauge. Treadplate 3003 bright finish 1/8" x 4' x 8' sheet.
3. Diamond Tread.

M. Door: 3’-0” x 7’-0”, 1-1/2 pair stainless steel hinges, lockset and deadbolt matching the Owner’s hardware systems for the main building project.

N. Anchorages: Anchor bolts; **hot-dip galvanized according to ASTM A 153/A 153M.**

O. HVAC: 800cfm Ventilation system: includes shutter-mounted fan, powered intake louver, thermostat, filtered weather hoods, and 4x4 electrical box and blank cover 1 1 Wall Mount Thermostat 4' - 1,000watt baseboard heater (230/1) - 752/1000 Convec Heater 4ft HEATER 24 - MARLY- Catalog # 2544W.

P. Lighting: Eight LED 4' - Kason 1810LCT4000

2.2 PREFABRICATED BUILDINGS, GENERAL

A. General: Provide complete, integrated set of mutually dependent components that form a completely assembled, prefabricated structures, ready for installation on Project site.

2.3 PREFABRICATED STEEL BUILDINGS

Manufacturers: Subject to compliance with requirements, **available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**:

1. Safespace
   PO Box 1579
   Manchester, MA 01944
   (877) 265-8820
   https://safespacebuildings.com

2. Modular Engineering Co
   1802 Cranberry Street
   Erie PA 16502
   (814) 838-6551
   Modularengineering.com

3. Commercial Structures Corp
   655 N. Tomahawk Trail, Nappanee, IN 46550. United States
   (800) 348-2740
   (574) 773-7931
   jlawrence@comstruc.com

2.4 FABRICATION

A. Fabricate buildoings completely in factory.

B. Preglaze windows and doors at factory.

C. Prewire buildings at factory, ready for connection to service at Project site.

2.5 FINISHES

A. **Galvanized-Steel** Factory Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.

1. Color and Gloss: **As selected by Architect from manufacturer's full range**.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install buildings according to manufacturer's written instructions.

B. Set buildings plumb and aligned. Level baseplates true to plane with full bearing on concrete bases.

C. Fasten buildings securely to **cast-in anchor bolts**.

D. Connect electrical power service to power distribution system.

E. Adjust doors and hardware to operate smoothly, easily, properly, and without binding. Confirm that locks engage accurately and securely without forcing or binding.

F. Lubricate hardware and other moving parts.

G. After completing installation, inspect exposed finishes and repair damaged finishes.

END OF SECTION 133423

SECTION 170010 - LIFE SUPPORT SYSTEM GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Scope of Work: This division covers the furnishing and installation of all saltwater, freshwater and chemical systems indicated on Drawings and as specified herein; including all piping, pipe supports, valves, pumps and motors, filters, automated controls and other miscellaneous work and required material, except those specifically noted otherwise.

B. Automated Controls Supplier (ACS) / Subcontractor is to be procured by the Contractor for installation of indicators, transmitters, and other controls devices associated with the Life Support System (LSS) Piping and Instrumentations Diagrams (P&IDs). The associated work shall be completed by the Contractor.

C. The work shall include furnishing all labor, equipment, tools, shop drawings, freight, appliances, hoisting, scaffolding, rigging, supervision and overhead for the proper execution and completion of the work. Provide necessary labor and material and other items as necessary to leave all exhibit saltwater, freshwater and chemical systems complete, tested, operative and satisfactory to the Owner.

D. Maintain equipment in as new condition until delivery to Owner.

E. Coordination of Work:

1. Contractor shall thoroughly acquaint himself with the work involved and shall verify at the site all measurements necessary for the proper installation of his work.
2. Contractor shall refer to architectural, structural, mechanical and electrical drawings for building construction and other details which affect the life support installation, and shall confer with those trades for finish adjacent to his work and arrange to have visible portions of his work (such as access doors, grilles, sprinkler heads, escutcheons, etc.) fit in and harmonize with the finish in a manner satisfactory to the Owner's Representative.
3. Ceiling heights: Architectural drawings shall be checked for ceiling height requirements.
4. Coordinate location of LSS piping with all other piping, ducts, and conduits that may be installed in certain areas. In cases where LSS piping and other materials conflict in space, refer the matter to the Owner's Representative for decision as to which material shall have control.
5. Pressure Testing: Contractor shall coordinate all pipe pressure testing activities, including written reporting to the Owner and advanced notification to the Owner of proposed testing times and locations.
6. Painting: Notify the General Contractor and other trades as necessary to assure coordination of all life support items requiring painting. The LSS Contractor is responsible for securing completion of painting as specified in Part 3 of these General Provisions.

F. Manufacturer's Directions: Each material for which the Manufacturer issues directions shall be used according to those directions, as approved, and if not at variance with these Specifications. If a variance between the Manufacturer's directions and these Specifications does exist, the Contractor shall bring it to the attention of the Owner's Representative for resolution prior to the commencement of work.

G. Examination of Site and Drawings: Submittal of bid shall indicate the Contractor has examined the site and Drawings and has included all required allowances in his bid. No allowances shall be made for any error resulting from Contractor's failure to visit jobsites and to review Drawings. Bid shall include costs for all required drawings and charges to meet space requirements, code requirements and as necessary to resolve space conflicts, at no additional cost to the Owner.

H. Contractor Prepared Drawings: The Contractor shall secure the service of a professional draftsman to prepare the "Shop" and "Record" drawings described below.

I. Start-up Operations: Provide appropriate craftsmen for startup of all installed equipment. See also Part Three of this Section under "Project Close-Out Requirements - System Start-up Operations." Startup by Contractor shall be the duration from beginning with checking of pump motor rotations and pressure testing of pipes to delivery of the complete operational system to the Owner.

J. Project Manual: The General Conditions of the Project Manual shall apply to this Section as fully as if repeated herein. This Section shall be coordinated with related Sections in Division 15 (such as pipe supporting and points of connection); except where conflict exists between Section 170010 and other Sections of Division 15, Section 170010 shall govern.

K. Technical Seminars: Contractor shall coordinate specified Technical Seminars, presented to the Owner and conducted by equipment suppliers, where specifically called for in the specifications. Technical Seminars shall be presented to the Owner by suppliers of the following equipment:

1. Section 170120 - Centrifugal Process Pumps
2. Section 170140 - Electric Valve Actuators
3. Section 170441 - Flow Meters
4. Section 170455 - ORP Sensors
5. Section 170723 - Ozone Equipment
6. Section 170753 – Calcium Reactors
7. Section 170786 – Reverse Osmosis

1.2 GENERAL ARRANGEMENT DRAWINGS

A. Coordination: The Drawings indicate the general routing of the piping and only critical dimensions and elevations are noted. The Contractor is required to coordinate piping fabrications with the civil and structural drawings. Discrepancies must be immediately brought to the attention of the Owners Representative for resolution. The Contract Drawings may not accurately reflect the actual configuration of materials the Contractor selects. The Contractor shall be responsible for coordination and layout for equipment and piping based on actual material dimensions.

B. Jobsite Conditions: The Contract Drawings show the general arrangements desired for the principal equipment, piping, valves, etc., and shall be followed as closely as possible; however, adjustments must be anticipated by the Contractor to meet field conditions. Proper judgement must be exercised in carrying out the work to secure the best possible headroom and clearances throughout, to secure neat arrangement of piping, valves, fixtures, hangers, etc., and to overcome local difficulties and interference of architectural, structural, and other conditions wherever encountered.

C. Diagrams Preside: The Contractor is to provide all piping necessary to carry out the process indicated on the Process Flow and/or Piping and Instrumentation Diagrams; the actual scale drawings show the general arrangement of equipment but do not show all piping, valves, instrumentation, equipment and points of connection that are required by the process diagrams.

1.3 DEFINITIONS AND STANDARDS

A. The word "provide," as used in these specifications, means "furnish all materials and do all work necessary for a complete installation." In many instances on the Drawings, specified work has been illustrated without annotation; in those cases where the illustration corresponds to either the diagrams or specifications or is a necessary interconnection, the work is to be completely furnished and installed by the Contractor; such items include, but are not limited to: FRP grates, ladders, pipe flanges, concrete pads, mounting brackets, pipe hangers and supports, etc.

B. Where or approved substitute is specified, the Contractor may choose any of the specified brand names or a non-specified brand meeting the specified requirements. Where no substitutes is specified, only the specified brands are acceptable.

C. Where "Typical" or "Typ." is used in the Contract Documents, the Contractor shall apply the reference to all similar applications irrespective of the degree of detailing that may or may not be shown for the similar applications.

D. References: The editions referenced herein of Federal Specifications (Fed. Spec.) and other standards and specifications published by the following organizations apply to the work only to the extent specified by the reference.

ANSI	American National Standards Institute
AISC	American Institute of Steel Construction
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing Materials
AWWA	American Water Works Association
AWS	American Welding Society
CSA	Canadian Standards Association
CISPI	Cast Iron Soil Pipe Institute
ETL	Edison Testing Laboratories
FM	Factory Mutual Engineering Corporation
IBC	International Building Code
ISO	International Organization for Standardization
NBS	National Bureau of Standards
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association

NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
PPI	Plastic Piping Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Inc.
UL	Underwriters Laboratories, Inc.
USASI	USA Standards Institute

1.4 CODES, PERMITS, AND INSPECTIONS

A. Codes: Work shall be installed in conformity with all local, state and federal codes, ordinances and statutes where they apply. Standards and sizes which meet or exceed preceding code requirements shall be installed as drawn or specified. Nothing in the specifications shall be construed to permit deviation from the requirements of governing codes.

B. Permits, Fees and Inspections:

1. Contractor shall arrange and pay for all permits, fees and inspections required in connection with this installation. He shall apply for and pay for all meters or gauges required. The Contractor shall present the Owner with properly signed certificates of final inspection before the work shall be accepted.
2. Contractor shall call for all inspections by the local authorities when they become due and shall not cover any work until approved by these governing authorities.

C. Testing Approvals: Testing Laboratory Requirements: Acceptable qualified testing laboratories shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) for Labels on Electrical & Mechanical Equipment. Acceptable listing agencies include Canadian Standards Association (CSA), Intertek Testing Services ITS-ETL, and Underwriters Laboratory (UL). Depending on the “Equipment Category” other testing agencies may be qualified by the State of North Carolina; such as NSF International and other approved research laboratories.

1.5 WORK INDICATED AS “NIC”

A. The term "NIC" shall be construed to mean construction work not to be furnished, installed or performed by the Contractor. The term shall mean "Not in this Contract" or "Not a Part of the Work to be performed by the Contractor," except that coordination and/or installation of certain NIC items specified shall be the Contractor's responsibility.

B. "NIC" work is indicated on the Drawings and specified herein as an aid to the Contractor in scheduling the amount of time and materials necessary for the completion of the Contract.

C. The following portions of the work will be provided by the Owner under separate contract or other arrangement:

1. (NONE)

1.6 OWNER FURNISHED EQUIPMENT

A. Owner's Responsibilities: The Owner will arrange and pay for product delivery to the site in accordance with the construction schedule. The Owner and the Contractor shall jointly inspect the deliveries for shortages and damaged or defective items. The Owner will arrange for replacement of damaged, defective or missing items.

B. Contractor's Responsibilities: The Contractor shall unload, uncrate, and store the products at the site and shall protect them from exposure to the elements and other damage. Items damaged after acceptance by the Contractor shall be replaced at the Contractor's expense. The products shall be installed, connected, adjusted and finished in accordance with the applicable section of these Specifications and the Manufacturer's instructions.

C. Owner will furnish the following equipment for installation by the Contractor:

1. (NONE)

D. Contractor shall obtain information to include in the *Operation and Maintenance Data Manual* from the Owner.

1.7 QUALITY ASSURANCE

A. Labor and Material: The intent of the Drawings and Specifications is to provide the Contractor with a basis for the construction and completion of every detail of the work described therein for a complete and fully operating mechanical system. Contractor must guarantee that the materials and workmanship supplied under these specifications are new unless otherwise approved by the Engineer and/or Owner in writing. Contractor shall properly store all materials and equipment for protection from physical damage or damage due to corrosion. The Contractor shall take all measurements, verify all drawings and be responsible for the proper installation in the available space of the equipment specified and shown on the Drawings and secure the approval of the Engineer for any variations before making any changes.

B. Drawings and Specifications: The Drawings and Specifications shall be taken together. Provide work specified and not indicated or work indicated and not specified as though mentioned in both.

C. Conflicts Between Drawings and Specifications:

1. Where disagreements occur between the Drawings and the Specifications or within either document itself, the item or arrangement of better quality, greater quantity, or higher cost shall be assumed for the base bid. If, in the opinion of the Contractor, there are omissions or errors in either the Drawings or Specifications, the Contractor shall verify those points and obtain clarification before bidding.
2. The Contractor shall carefully check space requirements to ensure that equipment, ducts, pipes, etc., can be installed in the spaces allotted. Lines that must pitch, or that must have a constant elevation, shall have the right-of-way over lines not so restricted.

D. Product Warrantees: Typically, the product specifications require warrantees starting at the date of startup of the complete system, or starting after Owner acceptance of the units from the installing Contractor, whichever is less. Product warrantees starting at the date that products are delivered to the Contractor is not acceptable and the Contractor shall coordinate with his product suppliers to have warrantees start at the specified times.

1.8 SUBMITTALS, APPROVALS, AND REVIEWS

A. General: Comply with requirements of Division 1, Section 01300.

B. Required Submittals: Submit material as designated in the subsection or otherwise as necessary to properly evaluate the item. Additional non-specified items submitted at the Contractor's option may or may not be reviewed at the discretion of the Engineer.

C. Submittal Review: The intent of this procedure is to have the Engineer review, for the Owner, actual material and equipment proposed to be furnished by the Contractor and to make comments where applicable. This review may serve as a checking process but in no case shall it relieve the Contractor from his responsibility of full compliance with Contract Documents including Drawings and Specifications.

D. Delay Notice: The contractor shall not have any right to file a delay claim based on the review of submittals without first specifically notifying the owner and the engineer and providing a reasonable turnaround time after such notification. The contractor shall confirm the engineer's receipt of submittals for review where a speedy processing time is required. Further, the contractor shall adhere to the submittal schedule, and/or submit material over a prudent time span, and not create a situation where the engineer is overloaded by tardy submittals for review.

1.9 SHOP DRAWINGS

A. Where shop drawings are called for in the specifications, or preparation of shop drawing by the Contractor are required for clarification, they shall be prepared as follows. The drawings shall be drawn by an experienced mechanical designer/draftsman. Use a suitable scale, not less than 1/4" = 1-foot 0-inch, verify all work in progress and field measurements, and draw neatly and accurately to a tolerance no greater than one-inch of actual installation. Prior to installation, submit shop drawings for review in digital or print form.

B. Submittal of shop drawings for review showing overall piping layouts and spool piece dimensions will be reviewed by the Engineer to check if the Contractor is in general conformance with the LSS design concept and the information shown in the Construction Documents; however, the Engineer will not review overall layout for every detail. The Drawings by TJP, Inc. have been prepared to a Level of Design (LOD) 300 and the Contractor shall take responsibility for producing shop drawings of overall piping to a LOD 400. Any changes to the Contract Document Drawings shall be clearly identified by the Contractor. The LODs shall be defined as follows:

1. LOD 300 — Construction Documentation by Engineer: Includes drawing and/or model detail and element that represent how system elements interface with various systems and other building elements with graphics and written definitions.
2. LOD 400 — Fabrication and Assembly by Contractor: Model or shop drawing elements are modeled as specific assemblies, with complete fabrication, assembly, and detailing information in addition to precise quantity, size, shape, location and orientation. Non-geometric information to the model elements can also be attached.

C. Prior to submission of any shop drawing, the Contractor shall thoroughly check each shop drawing to ascertain that it complies with the Contract requirements; that the plumbing, mechanical and electrical systems shown are correct and completely coordinated with the life support work.

D. No changes to Drawings or Specifications shall be made through shop drawings, unless specifically approved in writing by Change Order.

E. Include printed versions of approved shop drawings in the Operation and Maintenance Data Manual.

1.10 RECORD DRAWINGS

A. Comply with the requirements of Division 1. Corrections and changes shall be kept up-to-date at all times. Marked prints shall be kept at the jobsite for review by the Owner's Representative or their representative. Quality of Record Drawings shall be equal to or exceed the original Construction Documents.

B. The Record Drawings shall include the following minimum documentation:

1. Actual location of installed equipment, piping and utilities.
2. Re-define dimensions, or re-create drawings, where work varies from the design Construction Documents.
3. Indicate location of buried piping with dimensions to foundations or other permanent structures.
4. Clearly identify all points of connection ("P.O.C.") to existing equipment and other trades.
5. Show the installed arrangement where an approved substitution of equipment requires changes from the original design arrangement of life support equipment, adjoining work or other trades.
6. Incorporate changes associated with RFI responses, supplemental instructions, proposal requests, change orders, and the like.

C. The Contractor shall only submit Record Drawings which have incorporated dimensions from the pipe supplier's shop drawings.

D. Photographs: Record Documents to include photographs (chemical or electronic) of construction in-progress. Contractor shall take photographs of concealed equipment and buried piping and deliver photos/files to the Owner at the completion of the project. Specifically, photography shall include buried valves, buried connections with changes in materials, major pipe runs, and piping manifolds.

E. Responsibility for Accuracy: The Architect or Engineer will not certify the accuracy of the Record Drawings of construction which is the sole responsibility of the Contractor.

1.11 ELECTRONIC DOCUMENTS

A. Construction Documents: Electronic documents, if prepared by the engineer are for the express use in this single project. The engineer's design is to be bid and constructed from the printed documents and not from electronic files. The design is schematic in nature and electronic files shall not be assumed to carry a degree of precision beyond the information indicated on the printed documents. Electronic files shall not be reproduced or transferred for use beyond this specific project without the express written permission of the Engineer.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Exercise care during loading, transporting, unloading and handling to prevent damage to materials and equipment. Where possible all materials shall be stored at the job site in original manufacturer's packaging. Under no circumstances shall pipe, fittings, or any other material be dropped or dumped.

B. Store materials at the project site in enclosures or under secure protective covers in accordance with manufacturer's recommendations and as directed by the Owner's Representative. Do not store equipment directly on the ground.

C. Caution shall be exercised to avoid compression damage or deformation to ends of the pipe. Pipe shall be stored using methods to prevent sagging or bending and shall be protected from exposure to direct sunlight by covering with an opaque material.

1.13 GUARANTEE OF MATERIALS AND WORKMANSHIP

A. All work performed under this Contract shall be guaranteed against faulty and improper materials and workmanship for a period of 1-year from the date of final acceptance by the Owner, except that where guarantees or warranties for longer terms are specified in the project manual, such longer terms shall apply.

B. At no additional cost to the Owner, Contractor shall promptly correct any deficiencies which occur during the guarantee period, all to the satisfaction of Owner and Architect.

C. All equipment and installation shall be guaranteed by the Contractor to be installed in compliance with OSHA regulations.

D. The Contractor shall require similar guarantees from his subcontractors.

1.14 MAINTENANCE AND OPERATION DATA MANUALS

A. Prepare Instruction Manuals describing the operation, servicing and maintenance requirements of all mechanical equipment provided, and a complete parts list. Include Maintenance and Operation Data where specifically called for in Part 1 of the specified Subsection.

B. Information contained in the Manual: Catalog data on the particular item and not the complete "line" of the Manufacturer. Index all contents listed in an orderly presentation. Provide the following indexed chapters:

1. Valve Identification Chart that correlates M/O data with the tag numbers given on the Process and Instrumentation Diagrams.
2. Test Charts and Test Records.
3. Pressure Vessel Certificates.
4. Operation and Maintenance Data for all specified equipment. Include information, provided by the Owner, on Owner furnished equipment.
5. Guarantee and Warranties.
6. Pump and Equipment Installation Certificates (applies to all long-coupled “Process” type pumps).
7. Instructions for lubricating each piece of equipment installed. Instructions shall state type of lubricant, where and how frequently lubrication is required. Lubrication and lubricants especially shall be detailed separately for all equipment and presented for ready reference.
8. Supplementary Drawings for servicing and maintenance points.
9. A separate Sub-section with an itemized list of component parts with information giving where such parts can be purchased. Typewritten instructions for ordering and stocking spare parts for all equipment installed. The lists shall include catalog numbers of parts and suggested supplier.
10. Certified Operational Test Reports.

C. Delivery: Organize all information for delivery in an electronic PDF document. When assembling the electronic PDF use the “smallest size” possible function on large individual files before collation into the final presentation file. Where necessary, make presentation files no larger than 10MB and deliver multiple files separately. Publish with a front cover with the name of the Project, the Owner, the year of completion, the words "LIFE SUPPORT SYSTEM EQUIPMENT OPERATING AND MAINTENANCE DATA" and the names of the Architect, Engineer, General Contractor, and Mechanical Contractor.

PART 2 - PRODUCTS

2.1 PRODUCTS (SEE APPROPRIATE SUBSECTIONS OF DIVISION 17)

PART 3 - EXECUTION

3.1 GENERAL

A. This Section covers installation of the system in general and specific installation requirements given under individual equipment subsections are to be adhered to.

B. All the equipment shall be installed as recommended by its manufacturer. If any conflict arises between the manufacturer's instructions and any other directions, the Contractor shall bring the discrepancy to the immediate attention of the Owner's Representative.

C. Concrete Equipment Pads: Concrete pads for support and leveling of floor-mounted equipment shall be provided as follows:

1. Contractor shall install concrete equipment pads where shown on the Life Support, Architectural, or Structural Drawings for support of equipment using Structural concrete specified in Division 3.
2. Where floors are sloped, and/or where rooms have floor drains and are intended for routine washdown, concrete leveling pads shall typically be installed.
3. Where installation of equipment pads creates ponding of water, the Contractor shall install concrete “crickets” behind equipment pads to allow for drainage.

3.2 SAFETY AND PROTECTION

A. Safety Measures to be Taken: The Architect and/or Engineer has not been retained or compensated to provide design and construction review services relating to the Contractor's safety precautions or to means, methods, techniques, sequences or procedures required for the Contractor to perform his work. The Contractor will be solely and completely responsible for conditions of the jobsite, including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours. The Architect's and/or Engineer’s observations of the Contractor's performance are not intended to include review of the adequacy of the Contractor's safety measures in, on, or near the construction site. It shall be the Contractor's responsibility to comply with "Safety and Health Regulations for Construction," Volume 36, No. 75, Part II, of the Federal Register by the U.S. Department of Labor. Contractor shall be responsible for providing all such safety measures and shall consult with the state or federal safety inspector for interpretation whenever in doubt as to whether safe conditions do or do not exist or whether he is or is not in compliance with state or federal regulations.

B. Drive Guards: Provide OSHA approved drive and shaft guards for all exposed, rotating drive shafts and drive connections between motors and driven equipment including fans, pumps, compressors, etc. Guards shall include heavy-duty steel frames securely fastened for easy removal from the equipment frame. Guards, in general, shall be solid sheet metal with tachometer cutout at shafts where applicable. Guards for double-width fans and for air-cooled compressors, etc., shall be heavy mesh or expanded metal to permit air flow. Guards may be provided by the equipment manufacturer or fabricated by the Contractor to the Manufacturer's clearances, configurations, etc.

C. Head Protection: Where duct angles, pipe hangers, equipment support angles, etc., are exposed in walkways or in access ways for any maintenance, head protection must be worn. Cover all such potentially injurious protrusions less than 6-foot 8-inches above the floor with padding. Padding shall be securely and permanently fastened and finished comparable to adjacent finishes. The Owner's Representative shall be notified prior to the installation of any such protrusions

D. Site Observations: The right of the Engineer to conduct jobsite observation of the Contractor's performance is not intended to review the adequacy of the Contractor's safety measures in, on, or near the construction site.

3.3 CUTTING, PATCHING, AND PIPE PENETRATIONS

A. Contractor shall provide permanent seal for pipe penetrations at pools, basins and other hydraulic structures; including, walls and slabs located below the maximum ground water level as determined by the Geotechnical Engineer. Contractor's responsibility shall include, but not limited to, the following:

1. Accurately locate all such openings and coordinate work with General Contractor in order to properly complete this work within the General Contractor's time schedule.
2. Furnish the necessary drawings to trades whose materials must be cut or fitted.
3. Furnish sleeves, inserts, anchor bolts and similar items set into concrete, masonry, or the work of other trades, and be responsible for the exact location of all such items.
4. All drilling and cutting of holes in steel and fiberglass decks required for sleeves and supports. All additional openings required through existing slabs or walls shall be drilled with a diamond tipped core drill and in no case shall any structural member be cut without approval of Structural Engineer.

B. To prevent leakage in new concrete walls, piping with perimeter cast-in-place water-stop flange is generally assumed as the detail of choice with the LSS design. This detail requires pipe penetration through the concrete formwork. The intention of the "Link Seal" specified in Section 170280 is for repair situations in existing concrete and not intended to be a substitute for water-stop flanges in new concrete wall construction.

C. For pipe penetrations through dry, non-hydraulic walls, where required install with fire-stop joint sealant per Architectural specifications. Locations include floor and wall assemblies constructed of concrete, masonry, and drywall materials.

3.4 GENERAL INSTALLATION OF PIPING

A. The Contractor shall install all auxiliary piping and connections to equipment as required for a complete workable system, including equipment furnished by the Owner.

B. Tolerance of buried pipe elevations:

1. Where elevation call-outs indicate a slope in the pipe installation, the pipe shall be sloped continuously between elevation callouts.
2. Where elevation call-outs are identical in a section of pipe, the pipe shall be installed flat and true with no excessive high and low points. The contractor shall take all practical means for installing such piping as level with total variations in the installed piping elevations less than 25% of the pipe internal diameter. The lowest point in flat piping shall not exceed the highest point by more than 25% of the pipe internal diameter.
3. In no case shall buried piping be installed with high points, high loops, high risers over other construction materials, or high swales due to installation methods that may result in air pockets impeding the flow of water.
4. Where point-loaded supports are used with installation of buried pipe, the supports shall be temporary, with an above-grade length, of wooden material, and removed prior to final soil compaction.
5. The Contractor responsible for the installation of buried piping shall be present on site at the time of surrounding soil.

C. Supporting of exposed pipe:

1. Loads: Support all exposed piping with devices of appropriate design for gravity loads.
2. Locations and Submittals: When location and detail of pipe support are shown on the drawing, it shall be considered the minimum number and type required. Regardless of whether shown on the Drawings or not, provide support for all piping to conforming to these Specifications, field requirements, and applicable codes and regulations. *Location of all hangers and supports shall be submitted for approval prior to installation.* Provide lateral bracing at all major elbows, tees and flex connections.
3. Fastening: Anchor pipe supports by means of clamps or other approved means, securely fastened to the pipe and rigidly attached to the building construction. Refer to "Pipe Supports" Section 170310 and "Fasteners" Section 170316 for specific materials.
4. Spacing: The center to center spacing shall not exceed the piping manufacturers recommendations.
5. For insulated piping, reduce spacing of supports by 30% of recommended bare pipe spacing, to allow for the additional weight of the insulation.

D. Welded-on, or integrally-cast waterstops (or "anchor flanges") shall be provided in all pipes passing through concrete walls or slabs required to be watertight; walls and slabs required to be water tight shall include any tanks, pools, basins or other structures intended to hold water at any time and any walls or slabs located below the maximum ground water level as determined by the Geotechnical Engineer. Where piping passes through concrete walls of structures required to be watertight, the pipe shall be installed in the walls prior to placing concrete. All "PE" piping shall have anchor flanges where passing through all concrete structures including walls and slabs. PE anchor flanges may be fabricated by stick-welding and external anchor plate or manufactured by machining down the outside diameter of very thick PE pipe and leaving a raised anchor flange. Where water must be retained, backup wall flange waterstop with a full-circle strip of preformed plastic adhesive waterstop, by *Synko-Flex Products, Inc.* Houston, TX (800) 231-4551; or approved substitute.

E. Diagrams: Piping and Instrumentation Diagrams are schematic only and must not be used for obtaining lineal runs or number and type of fittings and fixtures.

F. Offsets in Piping: All offsets in piping, where needed to correct of field conditions, shall be approved by the Owner’s Representative prior to placement of effected piping.

G. Openings in Pipes: Keep covered at all times during the progress of work to ensure that no dirt or debris enters pipes or equipment.

H. Joints: Joints shall be in compliance with requirements of applicable codes and Manufacturer's recommendations. Threaded joints shall be made with an application of recommended Teflon pipe dope or Teflon tape. Threaded joints of different materials, such as Kynar/PVC or FRP/PVC, shall be made with both a Teflon tape wrap and an application of Teflon pipe dope.

I. Drains and Vents: Drain cocks shall be provided at low points and vent cocks at high points. Vent lines, with ball valves at a maximum height of five-foot above finish floor, shall be installed at all high points and piped to nearest floor drain. Where indicated on the Drawings, automatic air release valves shall be installed in addition to vent lines, with drain lines piped to the nearest floor drain.

J. Connections to Equipment: All piping connections to equipment shall be made with piping offsets and flanged unions or true union couplings as indicated on the Drawings or as required to allow equipment to be serviced or removed with as little dismantling of the immediate piping as possible.

K. Flanged Connections: Make-up joints with flanged faces true and perpendicular to the centerline of the pipe to which the flanges are attached.

1. Face Detailing: Faces of flanges must be flat, and without "O" ring grooves or other undulations, in order to be compatible with installation of valves and other attachments.
2. Flange Reinforcement: Where butterfly valves or other components create a "raised face" condition, it may be necessary to add an appropriate backing ring or shim to prevent bending of the flange. For installations where the operating pressure is less than 30-psi, depending on the flange manufacturer's recommendations, it may be possible to install standard non-metallic companion flanges without additional reinforcement. If the manufacturer recommends additional reinforcement: backing rings shall be constructed of Type 316 stainless steel or totally non-metallic; if shims are used to fill the raised portion of the flange, the shims shall be totally non-metallic.
3. Blind flange plates shall be of the same material as the flange (except where clear material is used). In the case of fiberglass, the plate may be slightly domed to reduce stresses and material thickness. Clear view-ports, or clear manway covers, shall be shall be hard-coated polycarbonate, acrylic, or approved substitute; sized for the pressure requirement by the supplier.
4. Where concentric tapered reducers are shown at pump discharges they shall be as specified herein. Thickness of the FRP flange shall not be less than as shown on Table 5 of NBS-PS15-69 for 150 psi design pressure. PVC bushings will not be considered as an acceptable equal. Typically pump discharges 3-inch diameter and larger shall be installed with 150 lb. concentric flanged reducers by, of FRP composite construction, by *Conley Composites* www.conleyfrp.com ; *Smith Fibercast* Little Rock, AR; *Ram Fiberglass* ramfiberglass@aol.com ; or equal. Pumps with 2-inch discharges may have PVC bushing reducers. If reducing fittings are not installed at pump discharges, a pipe spool shall be installed, for installation of valves, not less than two (2) pipe diameters in length.
5. Flat washers are required under all bolt and nut heads with additional split-ring lock washer on nut side, or as recommended by the fitting manufacturer.

L. Gaskets: Provide appropriate material and matching size for all required applications. Flange gaskets shall be manufactured to meet ANSI B16.1 dimensions. Recommend Durometer A hardness of 50 for plastic fittings and hardness of 65 for metal pipe. Provide ASAHI AV gaskets available from Harrington Plastics; or approved substitute.

1. Not required at booted or O-ring faced valves.
2. Not required at polyethylene-to-polyethylene flange joints.
3. For typical water applications use EPDM; may also substitute with higher grades of rubber such as Viton.

4. Use Nitrile rubber only where EPDM is not available and do not use Nitrile rubber where water is oxidized.
5. For oils and oil containing water use only materials rated to resist degradation from such specific oils.
6. For oxidized water applications use EPDM, Viton, *Teflon*, or PVDF.
7. For ozone gas applications use Teflon, PVDF, manufactured silicone gaskets, or *Gore-Tex* expanded PTFE adhesive-backed joint sealant strip. Material also required downstream of ozone gas fed venturi educators.
8. Do not use gaskets constructed of natural rubber or neoprene material.
9. For special hard-to-seal situations use *Gore-Tex* expanded PTFE adhesive-backed joint sealant strip, manufactured by *W.L. Gore & associates, Inc.* Elkton, MD (410) 392-3200 www.gore.com.

M. Over-Wrap Coating System: All buried metallic components, such as valves and flanges, shall be protected with the following coating system: STAC Coating System by *Central Plastics Company*, Shawnee, OK, (405) 273-6302; Graycoat/Guard-Wrap by *Trenton Corporation* Ann Arbor, MI (313) 426-3955; or approved substitute:

1. Wire-brush and clean all surfaces to be wrapped. If necessary, apply a hydrophobic primer over all metal parts.
2. Fill all voids and contour around irregular shapes with a petroleum filler.
3. Wrap entire component with a petrolatum saturated synthetic fabric.
4. Completely wrap and seal component with a tough self-adhesive PVC plastic over-wrap.

3.5 PIPELINE EXCAVATION AND BACKFILL

A. The Contractor responsible for the installation of buried piping shall be present on site from bedding of the pipe, at the time of installing embedment, and other times when the piping is affected by surrounding construction activities.

B. Required Reference Specifications:

1. PE/HDPE pipe shall be installed, per this specification subsection and, in accordance with AWWA Manual M55.

2. PVC pipe shall be installed, per this specification subsection and, in accordance with AWWA Manual M23 and AWWA C605.

3. FRP pipe shall be installed, per this specification subsection and, in accordance with AWWA Manual M45.

C. Shoring & Bracing: At open-cut excavations, whether by machine or hand excavation, the Contractor shall take all necessary precautions to prevent caving of trenches. Shoring, sheeting and bracing shall meet the requirements of State of North Carolina-OSHA. See other related Sections of the Project Manual and Special Conditions for safety requirements. Provide shoring and bracing where the depth of the excavation, or condition of the ground, require protection for safety, conforming with local and state safety laws and regulations. Either remove shoring before backfilling or, where necessary to ensure against caving, withdraw shoring while backfilling is performed. In no case shall bracing or shoring remain in place after completion of construction without prior written approval of the Owner's Representative.

D. Temporary Pumping Equipment: Furnish and maintain pumping equipment, as required to keep excavations free of water continuously, until backfilling is complete.

E. Final Backfill: Final backfill above the pipe embedment shall be completed per recommendations in the project Geotechnical Report and Civil design documents.

F. Embedment: Buried LSS piping shall either be backfilled with compacted soil or encased in Control Density Fill (CDF) as shown on the Drawings or as recommended by the pipe manufacturer. Soil backfill material may be Class II material for all types of pipe materials. CDF encasement may be used in place of compacted fill, at the discretion of the Contractor, where proper compaction is limited by congested piping situations, with the following exceptions:

1. Where buried PVC piping is located under hydraulic structures, PVC pipe shall be encased in CDF.
2. Buried PE/HDPE piping, located under hydraulic structures, may be installed with properly compacted backfill material or CDF encasement.
3. Buried FRP piping, located under hydraulic structures, shall be installed in structural concrete encasement in a steel reinforcing cage.

G. Backfill General:

1. Compaction: References to the percent compaction are a recommended in ASTM D4253.
2. No backfilling shall occur before hydrostatic pressure testing and all joints have been inspected and are leak-free.
3. Pipe is to be filled with water at a slight pressure (2 to 5 psi) during backfilling.

H. Special Trenching and Backfill for PE/HDPE Pipe per AWWA M55:

1. Trench and Foundation: The width of the trench must be of a sufficient width, to allow for soil compaction equipment, where CDF embedment is not installed. The existing (natural) soil foundation must have a stiffness equal or greater than the compacted backfill embedment. Where the foundation soil is unsuitable, the trench shall be over-excavated in both depth and width and replaced with a suitable stiff material. Where soil stiffness is in question, the value of 4,000 psi Modulus of Soil Reaction (*E'*) minimum shall be used for evaluation. In lieu of determination of Modulus of Soil Reaction (*E'*), soils exceeding 15-blows-per-foot field testing per ASTM D1586 may have sufficient stiffness.
2. Embedment: The embedment includes the bedding, haunch zone, and initial backfill. The embedment shall include the materials listed below or solid CDF encasement. Acceptable embedment materials include Class I (Crushed Rock) Class II (GW, GP, SW, SP) materials; however, in no cases are Class V materials allowed. Clean gravel embedment is recommended for buried PE/HDPE piping. Otherwise, CDF encasement shall be installed specifically where called for on the Drawings.
3. Bedding Below the Pipe: The bedding material shall be suitable for support of the pipe and rock or rock particles larger than those in Table 8-1 of AWWA Manual 55 shall be removed to a depth of 4-inch minimum below the pipe.
4. Haunch Zone: Extends from the bottom of the pipe to the springline (center) of the pipe. Take care to shovel-slice, or rod-in, backfill when placing the first lifts under the haunch of the pipe. Compact backfill embedment in 6-inch layers for 95-percent density.
5. Initial Backfill: The initial backfill for PE/HDPE pipe extends from the top of the haunch zone, to one-half the pipe OD, or 6-inch minimum or 12-inch maximum, above the top of the pipe. Compact the lower layer, adjacent the vertical pipe wall, to 95-percent density. Place the layer over the top of the pipe uncompacted to serve as padding for compacted soil directly above the pipe.
6. Final Backfill: The final backfill extends above the initial backfill and shall be installed per the project Geotechnical Report and Civil requirements.

I. General Trenching and Backfill for PVC (and non-PE non-HDPE) piping for installation in accordance with AWWA Manual M23 and AWWA C605:

1. Trench and Foundation: The width of the trench must be of a sufficient width, to allow for soil compaction equipment, where CDF embedment is not installed. The existing (natural) soil foundation shall meet requirements of Geotechnical and Civil documents.
2. Embedment: The embedment includes the bedding, haunch zone, and initial backfill. The embedment shall include backfill as recommended Geotechnical and Civil documents or solid CDF encasement. PVC piping shall be installed in CDF encasement under hydraulic (water containing) structures.
3. Bedding Below the Pipe: The bedding material shall be suitable for support of the pipe, where rock surfaces and large rock particles are not acceptable. The natural soil may be used where the foundation is graded to a smooth surface found acceptable for setting the pipe.
4. Haunch Zone: Extends from the bottom of the pipe to the springline (center) of the pipe. Where required to fill voids, shovel-slice, or rod backfill in place under the pipe haunch. Tamp backfill soil carefully around the pipe and fill carefully in 6-inch layers taking care not to dislodge the pipe.
5. Initial Backfill: The initial backfill for pipe extends from the top of the haunch zone over the top of the pipe. Compact the lower layer, adjacent the vertical pipe wall, to minimum of 90-percent density. Place the layer over the top of the pipe uncompacted to serve as padding for compacted soil directly above the pipe.
6. Final Backfill: The final backfill extends from above the initial backfill per Geotechnical and Civil requirements.

J. Final Backfill: Refer to the project Geotechnical Report, and Civil documents (specification Division 2), for fill and compaction above specified embedment zone of the LSS pipes.

K. Surplus Earth: Clay, organic materials, large rocks, and other excavated materials not suitable for backfill shall be removed from site and disposed of as directed.

L. Controlled Density Fill (CDF): Provide removable CDF slurry encasement as needed where piping is congested and/or proper soil compaction is not otherwise possible and where field conditions require CDF as directed by the Owner's Representative. CDF may be used in lieu of compacted fill at the contractor discretion. The purpose of the CDF is to eliminate trench settlement, prevent ovaling of flexible pipe walls, and speed construction by avoiding compaction. The CDF shall be designed by the local ready-mix concrete supplier to meet the following criteria.

1. Strength: 28-day compressive strength between 100 and 200 psi. May test with pick in lieu of standard compression testing equipment.
2. Portland Cement: 1.5% to 2.5% by weight (approx. one sack per cubic yard).
3. Fly Ash: 5% to 17% by weight, recommended to prevent segregation of the mix.
4. Aggregate: Coarse sand or 3/8-inch max. gravel.
5. Air Entrainment: 4% to 6% air content mix design to enhance flowability, testing not required.
6. Slump: 8 to 11-inches.
7. Quality Assurance: The CDF supplier shall establish quality control procedures to determine the CDF is adequate for its intended use.

M. Surface Restoration: Where existing pavement is damaged, it shall be neatly replaced with paving of the same specification.

3.6 INSTALLATION OF CONTROL SYSTEM COMPONENTS

A. Contractor (General Contractor or LSS Contractor) is responsible for providing all controls components. Related appurtenances include, but are not limited to *all* installation fittings and

sensing elements, control devices, transmitters, indicator and housings. This includes, but not limited to, the following general field devices and related appurtenances:

1. Motorized Butterfly Valves, per spec Section 170142.
2. Thermocouple and Sensing Wells, per spec Section 170430.
3. Flow Monitoring, per spec Section 170441.
4. ORP Sensors and Transmitters, per spec Sections 170455.
5. Level Sensors, per spec Section 17047.

B. Contractor (General Contractor or LSS Contractor) is responsible for providing all wiring and conduits.

C. All low-voltage control wiring, shall be installed in separate conduit from power wiring that is 30 volt or higher, and otherwise in compliance with the NEC for Class 1 wiring.

D. 4 – 20mA Wiring:

1. Where “2-wire” for low-voltage 4 – 20mA control wiring is not specifically called out on Drawings, or Electrical Documents, provide *Belden* 9802, 2 conductor, 20 AWG, with PP insulation; or equal.
2. Where shielded 3-wire is required, provide *Belden* 8772, 20 AWG, 3-wire; or equal.

E. LSS contractor shall coordinate installation with other trades involved.

F. Installation of ACS components shall be as indicated on the Drawings and component specification Sections. If specific installation instructions are not shown, provide in accordance with the Manufacturer's recommendations. Method of installation shall be similar in construction to those detailed on the Drawings for similar applications.

G. The LSS Automated Controls System (ACS) computer hardware and software shall be provided by the ACS supplier specified in Section 170933.

H. ACS cabinets, shall be provided by the LSS ACS supplier specified in Section 170933.

I. Final termination of LSS controls wiring shall be provided by the LSS ACS supplier specified in Section 170933.

J. Motor Actuated Valves: Provide flanges or other type of pipe fitting for installation of valve. Provide fasteners per Section 170316. Install per Manufacturer's recommendations and per valve specifications.

K. Thermocouple and Sensing Wells: Install per Manufacturer's recommendations. Locate sensing wells such that they are in the path of moving fluid and not positioned in stagnant or dead-end locations. Wells shall not obstruct the flow of the fluid being measured. Pipes one-inch and smaller shall be increased as required, but not less than one pipe size at point of insertion.

L. Flow Monitoring Installation:

1. Saddles for flow sensors shall be provided by the Contractor.
2. Contractor shall provide all separately mounted transmitters, indicators and other electrically powered equipment; including conduit, wiring, and mounting hardware.
3. Install flow indicators in a visible location with a secure mount (in general compliance with "Pipe Support" Specification).

M. Level Sensor and Controller: Install per Manufacturer's recommendations and as detailed on the drawings. Provide all mounting hardware.

N. Contractor shall perform all necessary coordination with the Electrical Contractor and shall ascertain provision of all required work. All conduit and wiring shall not disagree with the Electrical specifications in the Project Manual and shall be in accordance with local Electrical Code.

O. Installation of all ACS field devices, conduits and wiring shall be complete and fully-functioning prior to arrival of ACS supplier for his installation of controls software.

3.7 CLEANING, PROTECTION, AND FLUSHING

A. Cover All Pipe Openings: During construction the Contractor shall cover, cap and protect all pipe openings to prevent entry of debris.

B. Clean Work Area: Promptly remove all waste material and rubbish that may enter piping during construction.

C. Protect Equipment: Keep equipment covered during course of construction. Where this is not practical, clean and/or refinish item to new condition.

D. Protect Metals: Provide corrosion protection for all ferrous metal portions of work exposed to weather or in-service areas.

E. Final Clean-up: At completion of the work, but before painting, clean all dirt and construction debris such as paint, plaster, glue, cement, mastic, tar, paper, tape and dirt from the system components and LSS area.

F. Flushing: Piping shall be cleaned by the Contractor and free of foreign matter to the satisfaction of the Owner or his designated representative. Prior to filling of tanks and Life Support System:

1. Blow through gas piping and ducting with compressed air.
2. Flush all water piping with fire hose, for as long as required to thoroughly clean the system of debris. At each pump, back-flush suction piping with the largest available hose. At each tank, reverse flush all piping.

G. Jet Vacuuming: Where the Owner’s Representative has reason to believe stubborn debris remains in the piping, the Contractor shall scour the suspected pipeline with a jet nozzle/vacuum system. *Vactor Manufacturing, Inc.* (815) 672-3171 www.vactor.com; or substitute.

H. Strainer baskets shall be inspected and cleaned as a last step when cleaning the system.

I. Contractor Certification: Before start-up, the Contractor shall certify that the system has been flushed and cleaned.

J. Damage: Valves or other system components which do not function properly because of imperfect cleaning of any piping system shall be replaced at the Contractor's expense, including all labor costs.

3.8 PIPE PRESSURE TESTING

A. General: Provide all testing and adjusting necessary to place all systems and items of equipment in proper operating condition. All work shall be completely tested prior to backfilling, or covering in any way, of pipes or filling of any structures or exhibits. All equipment and apparatus required for performing tests shall be provided by the Contractor. All defects disclosed by the tests shall be corrected and the tests repeated.

B. Extent: All underground piping and all major transmission shall be pressure tested. Above ground branch piping connecting to life support equipment need only be operationally tested.

C. Piping has been designed for working conditions only. Any devices, restraints, thrust blocks, etc. required for testing shall be the Contractor's responsibility.

D. Notification: Contractor shall provide advanced notification to the Owner of proposed testing times, locations, and summarize test results in a written report.

E. Testing Procedure:

1. After installation is complete, but before piping is buried, encased or before insulation is applied, all piping and equipment shall be tested and proved watertight under the following conditions or as required by governing ordinances. Test pressures given below are not applicable if any temperature exceeds 100 deg F.

SYSTEM	GAUGE PRESSURE OF TEST	TEST WITH	ALLOWABLE LEAKAGE	DURATION
Rigid Saltwater Piping	80 psi	Water[2]	None	3 Hours
Flexible Saltwater Piping	90/80 psi[3]	Water[2]	None	3/1 Hours[3]
Ozone Piping	100 psi	Air	None	3 Hours
All Other Piping[1]	Per Application	Water[2]	None	3 Hours

Notes: [1]This shall include all pressure piping for water but not to exceed test pressures recommended by the pipe and/or fitting manufacturers. [2]Air testing of non-metallic piping is not allowed. [3]Conduct expansion phase and test pressure phase testing as described below.

2. Pressurized Equipment: Contractor shall be responsible for determining the allowable test pressure of all connected equipment. If this pressure is less than the required system test pressure, the Contractor shall isolate the piece of equipment in question from the system for the duration of the test. Isolation shall be achieved by means which does not preclude the testing of any other portion of the system.
3. Test Log: Prepare and maintain records of all piping systems tests; use Dickson or Bristol Recording Gauges on all tests. Records shall show Contractor personnel responsibilities,

dates, test gauge identification numbers, ambient temperatures, pressure ranges, rates of pressure drop and leakage rates. At completion of testing, logs of tests shall be certified, signed by the Contractor and a designated Owner's Representative. The Test Log shall be kept current and be available on site for review by the Owner.

4. Tolerance for Rigid Piping (including PVC, FRP, and metal): The test pressure shall remain for the specified duration within plus/minus 1.0 psi.
5. Tolerance for Flexible Piping (including polyethylene):

    a. Fill all piping with water while venting air at high points.
    b. Conduct 3-hour expansion phase test with pressure at 90 psi. When the water temperature is above 80 deg F, the test pressure shall be reduced as recommended by the pipe manufacturer.
    c. Conduct 1-hour pressure test at 80 psi, for water temperature of 80 deg F or less, where the pressure shall be within plus/minus 4.0 psi of the initial test phase pressure. When the water temperature is above 80 deg F, the test pressure shall be reduced as recommended by the pipe manufacturer. Contractor shall have all joints wipe checked for leakage during pressure test. The barrel of the pipe between joints may be buried to enhance thermal stability and safety.
    d. Depressurize the pipe and do not re-pressurize within an 8-hour time span.

6. Ozone Gas Piping: Single-wall ozone gas piping shall be checked at each fitting by using a "soap bubble" test. Dual-wall ozone gas piping shall be operationally tested.
7. Temporary Piping: It is the Contractor's responsibility to plan for the testing procedure and to provide all necessary plugs, flanges and fittings, or temporarily cap pipes, to perform the tests.
8. Non-Testable Systems: Some piping systems may have non-isolatable components or temporary closures may not be practicable. Such systems shall be carefully inspected upon startup and no leakage is acceptable.
9. Concealment: No plumbing, heating or air distribution system shall be covered, concealed or put into use until it has been tested, inspected and accepted.
10. Equipment: Contractor may need to obtain a special hydrostatic test pump as manufactured by Chern Industries Incorporated, Minneapolis, MN, or equal, should available domestic water pressure fail to meet above requirements.
11. WARNING: Take suitable precautions to eliminate hazards to personnel near piping being tested and stay at a safe distance away from the test section. Piping systems may rupture suddenly and resulting in forceful movement upon failure of pressure test.

3.9 PRELIMINARY OPERATIONS

A. Should the Owner desire that any portion of the life support system be operated in addition to the tests required under the specifications, prior to the final completion and acceptance of such work, the Contractor shall provide necessary labor and supervision for such operation as directed by the Owner's Representative. The costs of this operation, including the necessary fuel, water, electric power and labor (but not including Contractor's supervision), will be paid by the Owner. Such preliminary operation or the payment thereof, shall not be construed as an acceptance of any of the work of the Contract.

B. The pumps, filter piping, basin piping and flow sensors and indicators must be operable prior to the installation of the filter media.

3.10 SYSTEM START-UP OPERATIONS

A. The term "system" shall mean all life support equipment necessary for the normal operation of all exhibit recirculation systems, exhibit filtration and disinfection systems, support systems and any sub-systems.

B. Prior to start-up, obtain approval of schedule and coordinate operational testing with Owner's Representative and Engineer.

C. Contractor shall fill tanks, pools, basins, and other hydraulic structures to the correct full levels, successfully start, operate, stop and secure all mechanical plants under this project for three, 6-hour periods on three consecutive weekdays.

D. Start-up Strainers: Provide temporary in-line strainers in the intake piping upstream of each pump installed per Manufacturer's recommendations, except for pumps already equipped with permanent basket type strainers in the suction lines suction lines. Where strainer is mounted adjacent to a butterfly valve, provide spacer to allow for proper opening of the valve. Do not install strainers that may project into the suction nozzle of the pump. Keep strainers in place during at least the first 72-hours of full operation. Periodically check the strainers for accumulation of debris that may hinder the performance or reliability of the pump operation. In-line strainers shall be as follows:

1. Only cone type or truncated cone (basket) type strainers will be considered acceptable.
2. Strainers shall be constructed as required for operation of the system at peak hydraulic velocities. Strainers 8-inch, 10-inch and 12-inch in diameter shall be constructed of 14-gauge minimum material.
3. Shall be of stainless-steel construction.
4. Percent open area to the pipe cross-section shall be 150% minimum.
5. Minimum perforation size shall be 1/8-inch, recommended perforation size is approximately 1/24 the pipe diameter.
6. Strainers shall have visible identifier tab extension.
7. Provide "conical" type or "basket" type, manufactured by:

    a. *Mueller Steam Specialty* Lumberton, NC (919) 738-8241;
    b. *Process Strainers Inc.* Houston, TX (713) 890-4600;
    c. or approved substitute prior to use.

E. High Point Vents: Evaluate piping for possible blockage of water flow by air trapped at high points and install vent lines, with valves located for operation at floor level, and piping terminated at floor level pointing to floor drain.

3.11 PAINTING

A. General Requirement: The Mechanical Contractor shall notify the General Contractor and other trades as necessary to assure coordination of all items requiring painting. Painting shall be done in accordance with Division 9, "Painting".

B. Items not to be painted are: Stainless steel and aluminum, fiberglass and PVC items inside water containing structures, factory epoxy-coated instrument cases, nor identification tags, plates or labels. Mask pump seals.

C. Owner Furnished Items: The Contractor shall ascertain the type of coating for compatibility prior to painting.

D. Steel Filter Vessels: Finish in accordance with Section 170020.

1. Inorganic Zinc Primer with high solids epoxy and aliphatic acrylic polyurethane topcoasts.
2. Verify color of final topcoat with Owner.
3. Color Schedule (verify exact matches with Owner).
4. Filters & Pressure Vessels: Color selected by Architect or Owner.

E. All Exposed PVC: Clean surfaces as required. Do not paint.

F. Exposed Polyethylene (PE) Pipe: Clean surfaces as required. Do not paint.

G. Pumps:

1. Do not paint shaft, couplings, or seals located on shaft between pump and motor.
2. Metallic Pumps:

    a. Surface Preparation: Remove any rust and clean with *Carboline* Surface Cleaner #3 and thoroughly rinse, or use other recommended cleaner.
    b. Prime Coat: *Carboline* Rustbond PS; or corrosion-resistant coating as recommended by the pump manufacturer.
    c. Intermediate & Topcoats: *Carboline* Carboguard 890; or approved substitute as given in Specification Section 09900 for "Miscellaneous Steel". Apply each coat to a dry film thickness of 4 mils minimum.

3. Non-Metallic Pumps: Do not apply overcoat to non-metallic components. Touch-up manufacturer's coatings if damaged. All metallic components, including power frame, motor and base, are to be painted as described above for metallic pumps.
4. Ferrous Metal Pump Bases: Prime and paint all metal pump bases, including underside, as specified below under "Submerged and Wet-Dry Exposed Ferrous Metal Surfaces" with *Carboline* Carboguard 891 VOC or approved equal.
5. Non-Metallic and Stainless-Steel Pump Bases: Do not paint.

H. Valves: Repair damaged coatings as necessary to restore original finish.

I. Supports:

1. Ferrous Metal: per Specification Section 09900 for "Miscellaneous Steel".
2. Aluminum: Apply epoxy "isolation" coating as specified in Section 170310.
3. Non-Corrosive Materials: Do not paint.

J. Hot Dip Galvanized Repair: Where galvanized surfaces have been damaged, or otherwise missing a portion of the original coating, apply a cold galvanizing compound containing 95% zinc dust by weight in the dried film. Product shall have passed the Preece Test per ASTM A-239 for hot-dip galvanizing and meet or exceed ASTM A-780 standard for repair of damaged hot-dip galvanized coatings. Apply two coats for a total final dry film thickness of 3-mils minimum. The manufacturer shall be registered by Underwriter's Laboratories for ISO 9001 Series Standards for Quality. *Galvilite* by *ZRC Worldwide* Marshfield, MA (800) 831-3275 www.zrcworldwide.com.

K. Submerged and Wet-Dry Exposed Ferrous Metal Surfaces:

1. Surface Preparation: Abrasive blast in accordance with SSPC SP 10, near white metal cleaning and achieve an angular anchor profile of 1 to 3 mm.
2. First Coat (Prime Coat): Inorganic zinc primer with not less than 80% total zinc in the dry film, excellent resistance to saltwater atmospheres, and proven compatibility with topcoat. *Carboline* "Carbozinc 11 HS", *Porter* "Zinc Rich Epoxy Primer" applied at 2.0 - 3.0 mils

DFT; or approved substitute. Must be applied by spraying in a controlled area, and in a manner that does not cause disbondment of the topcoat. Prime Coat is *not* compatible with alkyd paint; topcoat must be high in solids.

3. Second and Third Coats: *Carboline* 891 VOC or approved equal. Spray apply each coat to a dry film thickness of 2-3 mils or manufacturer's recommended DFT.

L. Dry Exposed Ferrous Metal Surfaces Not Exposed to UV or Sunlight:

1. Surface Preparation: Abrasive blast for an anchor profile of 1-3 mils, in accordance with SSPC-SP 10.
2. Prime Coat: As required by coating manufacturer.
3. Second and Third Coats: A high performance, multi-purpose, surface tolerant acrylic or epoxy coating specifically recommended by the manufacturer for exposure to salts and moisture. *Carboline* 890 Series Cycloaliphatic Amine Epoxy; "BAR-RUST 235" Multi-Purpose Epoxy Coating, by *Devoe Paint*, Louisville, Kentucky (502) 897-9861; or approved substitute. Spray apply each coat to a dry film thickness of 4 mils minimum or thicker DFT where recommended by the coating manufacturer.
4. Other Equipment or System Components: Repair damaged coatings as necessary to restore manufacturer's original finish.

M. Dry Exposed Stainless Steel and Aluminum Metal Surfaces:

1. Outdoor: Coat all outdoor exposed bare stainless steel and aluminum surfaces with a penetrating lubricant with a waterproof waxy finish. For locations in possible contact with animal waters, use food grade lubricant specified in next item below. Product: Boeshield T-9 by *PMS Products, Inc*. Holland, MI (800) 962-1732 www.boeshield.com; LPS 3 Premier Rust Inhibitor by *LPS Laboratories* Tucker, GA (800) 241-8334 www.lpslabs.com; or approved substitute.
2. Locations above water tanks or indoor locations in the vicinity of saltwater spray or potentially corrosive locations: Coat all outdoor exposed bare stainless steel and aluminum surfaces with a penetrating lubricant with a waterproof waxy finish. Product: LPS FOODLUBE Penetrating Oil Synthetic Lubricant by *LPS Laboratories* Tucker, GA (800) 241-8334 www.lpslabs.com; or approved substitute.

3.12 IDENTIFICATION OF PIPING AND VALVES

A. Pipe Markers: Identify all pipe with durable vinyl plastic adhesive backed lettered labels in accordance with functions listed in the Piping & Instrumentation Diagrams (P&IDs). Pipe markers shall conform to the requirements of the "Scheme for the Identification of Piping Systems" ASME A13.1 (latest edition) and letter sizes shall be in accordance with the USASI Standard. Straight lines of pipe shall be identified at intervals of 20 feet, and at least once in each room. Piping also shall be identified at points near all turns, valves, at the upstream side of fittings or branches, and each side of wall crossings. Apply black arrows adjacent identification labels to indicate direction of flow.

B. Pipe Markers: Identify all pipe with durable vinyl plastic adhesive backed lettered labels in accordance with functions listed in the Piping & Instrumentation Diagrams (P&IDs). Pipe markers shall conform to the requirements of the "Scheme for the Identification of Piping Systems" ASME A13.1 (latest edition) and letter sizes shall be in accordance with the USASI Standard. See following Color Schedule Matrix and verify exact matches with Owner.

C. Valve Tags: Durable, rigid plastic, or stainless steel tags. All tags shall be of a neat uniform design, with lettering embossed in metal or engraved plastic. Tags shall clearly identify the number of the valve as indicated on the P&IDs or as designated by the OWNER.

D. Proposed Pipe Marker Color Schedule Matrix, Contractor shall select a marker supplier with available colors as close as possible to matching the following list:

PROCESS FLUID DESCRIPTION	Color (Brady Corp)	Pantone ® Color Code (Ref)	COLOR SAMPLE	PROCESS ID
ACID OR BASE	Pink	230		ACID / BASE
SALT BRINE	Tan or Gold	117		BRINE
BACKWASH WATER SUPPLY	Sky Blue	2975 / 544		BWS
BACKWASH WATER DRAIN	Brown	4645		BWD
BYPASS	Grey	444		BYPASS
CHEMICAL PIPING	Pink	230		CHEM
CHILLER PROCESS WATER	Blue	301		CHL
COMPRESSED AIR (GENERAL)	White			CA
CONDENSATE	Grey	444		CND
DEIONIZED WATER	Purple	512		DI
DOMESTIC or CITY or POTABLE WATER	Light Blue	279		CW/POT/PWS
DRAIN	Grey			DRAIN
EQUALIZER	Blue	301		EQ
FRESHWATER BACKWASH SUPPLY	Light Blue	279		FWBWS
FRESHWATER BACKWASH DRAIN	Brown	4645		FWBWD
FRESHWATER MAKEUP	Light Blue	279		FWMU
FRESHWATER SUPPLY TO EXHIBITS	Sky Blue	2975 / 544		FWS
FRESHWATER RETURN FROM EXHIBITS	Green	3278		FWR
HEAT EXCHANGER PROCESS WATER	Blue	301		HEX
HEATING WATER SUPPLY (HOT)	Red	185		HWS
HEATING WATER RETURN	Red	185		HWR
NITRIFICATION/DENITRIFICATION	Orange	1575		DENITE
NON-POTABLE WATER TO LSS	Yellow			NPW
OVERFLOW	Blue	301		O/F
OZONE OFFGAS	Yellow			OFFGAS

PROCESS FLUID DESCRIPTION	Color (Brady Corp)	Pantone ® Color Code (Ref)	COLOR SAMPLE	PROCESS ID
OZONE GAS	Pink	230		OZG
OZONE WATER PROCESS	Orange	1575		OZW
PROTIEN SKIMMER SUPPLY OR RETURN	Tan or Gold	117		PSK (FRR/FRS)
PURGE	Purple	512		PURGE
RECOVERED SALTWATER	Sky Blue	2975 / 544		RSW
RAW SALTWATER SUPPLY	Green	3278		RSWS
RECLAIMED WATER	Purple (must be Pantone 512)	512		RCW
R.O. FRESH (OR PRODUCT)	Sky Blue	2975 / 544		RO
R.O. SALT (OR REJECT)	Brown	4645		REJ / BRINE
SAMPLE WATER	(Match Source Water)		N/A	SMP
SALTWATER BACKWASH SUPPLY	Green	3278		SWBWS
SALTWATER BACKWASH DRAIN	Brown	4645		SWBWD
SALTWATER MAKEUP	Green	3278		SWMU
SALTWATER SUPPLY TO EXHIBITS	Sky Blue	2975 / 544		SWS
SALTWATER RETURN FROM EXHIBITS	Green	3278		SWR
SEAWATER INTAKE	Green	3278		SWI
TRANSFER PIPING	Red	185		TRANS
ULTRAVIOLET STERILIZER PROCESS	Purple	512		UVS / UVR
VACUUM WATER	Grey	444		VAC
VENT (NOT OZONE)	Grey	444		VNT

E. Manufacturers:

1. *Brady Corp, Inc.* Milwaukee, WI (855) 436-9531 www.bradyid.com;
2. *Christy Enterprises, Inc*. Orange, CA (714) 507-3300 www.igin.com;
3. or approved substitute.

F. Ozone Systems Tags:

1. Ozone gas supply lines shall be labeled OZONE GAS & OXYGEN - HIGHLY TOXIC – OXIDIZER.
2. Ozone contactor off-gas lines shall be labeled OZONE OFFGAS & OXYGEN - HIGHLY TOXIC – OXIDIZER.

G. Valve Tags: Identify life support valves with durable rigid plastic, or stainless steel tags. All tags shall be of a neat uniform design, with lettering stamped in metal or engraved in dual color plastic material. Tags shall clearly identify the number of the valve as indicated on the P&IDs or as designated by the Owner. Omit tags on fixture stops of utility plumbing.

H. Submittals: Prior to installation, submit samples of pipe markers and valve tags for review.

I. Manufacturers:

1. *Brimar Industries Inc.* Garfield, NJ (800) 274-6271 www.brimar.com;
2. *Christy Enterprises, Inc.* Orange, CA (714) 507-3300 www.igin.com;
3. *Seton Name Plate Corporation* New Haven, CT (203) 772-2520 www.seton.com;
4. or approved substitute.

3.13 PROJECT CLOSE OUT REQUIREMENTS

A. General Requirement: Completion of each of the following items is conditional to acceptance of the work by the Owner.

1. Guarantee: Submit guarantee of materials and workmanship.
2. System Start-up Operations: Provide materials and labor for system start-up operations. Demonstrate full functionality of all equipment.
3. O&M Data: Submit Life Support Systems Operating and Maintenance Data Manual.
4. Shop Drawings: Include printed versions of approved shop drawings in the Operation and Maintenance Data Manual.
5. Pressure Testing: Submit pressure testing logs.
6. Record Drawings: Submit Record Drawings ("As-Builts") to the Owner. Include "As-Builts" of isometric shop drawings.
7. Samples: Submit to the Owner’s Representative any requested samples.
8. Clean-up: Comply with requirements for cleaning equipment and premises.
9. Detachable Parts: Deliver to the Owner's Representative all special tools required for proper operation and maintenance of the equipment, portable/detachable parts, keys or other devices provided.
10. Technical Seminars: Coordinate delivery of Technical Seminars presented by suppliers of ozonation equipment (Section 170723) and flow meters (Section 170442).

B. Functional Testing of Life Support Systems (LSSs) by Contractor: All systems and components shall be functionally tested by the Contractor. This generally includes initial operational startup of the LSS piping systems and components by the Contractor, including checking pump motors for proper rotation, running of pumps with water, operation of all LSS with water flowing, normal operation of filter and backwashing of filters, LSS components, operation of all piping systems without any apparent leaking, and in general insuring that all LSS are in a fully functional condition when delivered to the Owner.

1. Contractor shall be responsible for familiarizing himself, and the Owner’s staff with his completed work, and understanding all the projects design & construction documentation including piping and instrumentation diagrams (P&IDs), equipment layouts and equipment specifications.

2. Functional testing shall be determined as complete when recorded as “satisfactory” by the Owner’s operational staff.
3. Functional testing may be limited to subsystems, such as a heat exchanger pumping loop; in which case neither the heat exchanger or the pump shall qualify as functionally tested until the entire subsystem is shown to operate to the satisfaction of the Owner; in the case of functional testing of an overall LSS the requirement for retesting of a small subcomponent shall not necessarily require a retest of the entire LSS.
4. Contractor shall be responsible for attending Owner’s startup meetings and other project team and scheduling meetings as appropriate & necessary. The Contractor shall assign the task of functional startup of the LSS to a specific staff member.
5. Contractor will work with the Engineer of Record, product representatives, and the Owner’s staff and representatives to perform operational checks, and start-up routines of the installed equipment.
6. Regarding work site safety, the Contractor shall provide recommend operational procedures, and training, necessary for safely & effectively conduction work at the site.
7. Contractor shall provide all physical operations, powering of equipment, and physical adjustments.
8. Contractor shall ensure the LSSs are hydraulically balanced and all equipment is functioning as designed and specified to his knowledge.
9. Contractor shall document any and all deviations from the Contract Documents and relay to the project team. These deviations shall also be incorporated in Record Drawings prepared by the Contractor.
10. Where Contractor is in possession of instrumentation, or test equipment, for documentation of equipment performance, the Contractor shall provide such equipment and operational staff for data gathering during on site time by the Owner’s staff or designated representatives.
11. Where Technical Seminars are included in the Contract Documents, for startup and calibration of equipment by manufacturer’s representatives, the Contractor shall include reports summarizing the Technical Seminars.
12. Contractor shall prepare written field reports outlining issues and concerns related to start-up including all status and issues occurring during the design professional’s on-site Construction Administration services.

END OF SECTION

SECTION 170024 - CUSTOM FABRICATED PRESSURE FIBERGLASS FILTERS

PART 1 - GENERAL

1.1 USAGE

A. The pressure fiberglass vessels with sand media, or glass media, are used for water filtration

B. The pressure fiberglass vessels with carbon media are used for removal of ozone, which is a very strong oxidant, from solution. A special liner for these vessels is to be provided with an anticipated useful life of no less than 10-years.

C. Port Locations:
   1. Small Vertical Filters: Filters less than 48-inch diameter, may have ports limited to the sidewall, as indicated on the Drawings.
   2. Large Vertical Filters: All vertical style filters, 48-inch diameter and larger, shall have the top inlet pipe port centered on the top dome of the filter vessel — no exceptions. The outlet pipe port shall be on the lower portion of the vertical cylinder of the side shell.

1.2 SUMMARY

A. Filter shells and internals shall be supplied as specified herein. Media shall be supplied by the Contractor per Section 170062. The General Conditions shall apply to this Section as fully as if repeated herein.

B. Summary of design criteria (also as specified elsewhere within):

   1. Positive Design Pressure for 48-inch diameter “Recovery” (REC) filters, and “freshwater makeup” (FMU) filters: 75 psi.
   2. Positive Design Pressure for exhibit recirculation filters: 50 psi.
   3. Test Pressure: 1.1 times Design Pressure for 4-hour duration.
   4. Maximum strain: 0.001 at test pressure.
   5. Minimum Burst Pressure: 4-times the Design Pressure
   6. Negative Pressure Capability: 5-inch mercury

C. General construction detailing, as shown on the Drawings, shall be adhered to. The contractor shall implement all required changes in detailing and bear any additional costs for design, engineering, labor, materials, and product verification for any variations in geometry from what is shown on the Drawings.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: The FRP fabricator shall have at least 10-years of experience in the manufacture of similar items with a record of successful installations.

B. Internal Photo Documentation: Prior to filling with media, the Contractor shall make a photo documentation and inspection of the internals for each filter. All delivered filter vessel shall be inspected for any damage including the security and quality of all interior

distribution piping. Of particular interest are the conditions for the attachment of each lower distribution lateral pipe.

1.4 TESTING

A. The supplier shall perform an in-shop hydrostatic pressure test of all sizes of each filter built.

B. Filters shall be tested at 1.1 times the design pressure for a 4-hour duration. No leakage is allowed and vessel shall be within specified strain allowance at the test pressure.

C. The supplier shall log as-tested data for each filter and deliver copies of the test data to the Owner or specifying Engineer for approval before shipment. The test log shall include:

1. Vessel Tag Number and Size.
2. Date & Time.
3. Actual Test Pressures (start, mid and end).
4. Circumferential Strain (vessels 48" diameter and larger).
5. Axial Strain (vessels 48" diameter and larger).
6. Leakage & Comments.
7. Name of individual conducting the test.

D. Strain Measurements: Vessels (48” diameter and larger) shall be measured around the circumferential and longitudinal axis for strain before, during and after testing. Strains are to be measured using the test pressure. Dimensional strains shall not exceed 0.001.

E. Responsibility: Strain measurements shall be certified by the manufacturer, Professional Engineer, or testing company.

F. Verification of Resin Cure: Optimum resin cure shall be checked and confirmed for each vessel by testing surface hardness in accordance with ASTM D 2583 Standard Test Method for Indentation Hardness for Rigid Plastics by Means of a Barcol Impressor. When post-fabrication heat cured, test afterward. Additionally, surfaces shall be carefully inspected for imperfections or holidays. The testing and inspection for each vessel shall be certified by the manufacturer in a Final Inspection Report.

G. Supplier shall notify the purchaser of the testing schedule and permit the Owner or their Representative access to the fabrication facility and witnessing of testing.

1.5 SUBMITTALS

A. Submit the following for review, prior to commencement of any fabrication:

B. Shop drawings with filter dimensions and list of materials.

C. Photographs of similar vessels produced by same fabrication shop of sufficient detail to determine quality of work.

D. Complete set of scale shop drawings indicating all dimensions and laminate and "weld" design, along with a complete material take off. Shall include detailed drawings for proposed connecting of lower lateral distributors to the lower manifold.

E. Calculations verifying basic stress and strain of the pressure vessel, external loading of attachments, and lateral loading. Include references to Codes where applicable.

F. Samples, or color photographs, of lower slotted distributor laterals and upper distributor piping (upper only if not integral with vessel shell).

G. Submit information from resin manufacture giving finished Barcol hardness values.

H. Example, sample, or photo of proposed exterior coating (standard light grey).

I. After fabrication of vessels, but before shipment, submit the following:

1. Copies of pressure testing log for each individual vessel.
2. Pressure testing report signed by corporate principal on vessel manufacture's letterhead or signed by Professional Engineer (individual or as member or testing company).
3. Certificate of heat curing, where vessels are specified with an ozone-resistant vinyl ester resin liner.
4. Manufacturer's certified Final Inspection Report addressing hardness testing, finish workmanship, quality of lower lateral connections, security of lower laterals for shipping, and other quality control aspects.

J. Warranty (described below).

K. Contractor shall submit report for inspection, with photo documentation of the internals, for each filter prior to filling with media.

1.6 WARRANTY

A. Supplier shall warranty each vessel to be free from defects in manufacturing, workmanship or materials and agree to repair or replace any fabrication within 5-years from date of delivery on a non-prorated basis and not less than 15-years on a pro-rated basis.

B. Specific "defects," include: Any outright failure of bonds, any evidence of leaking through laminate layers, leaking past gasketed mating surfaces as a result of tolerances in excess of those specified by NBS, radial hoop cracking (superficial or structural) in excess of 10-percent circumference of vessel or attachment, delamination or crazing or other deterioration of the exterior coating as a result of exposure to sunlight or saltwater spray or normal weather conditions. Any defects in workmanship such as dry windings, insufficient bonds or uncatalyzed resins.

PART 2 - PRODUCTS

2.1 FABRICATIONS

A. Usage:

1. Sand-media vessels are used for filtering animal exhibit water containing debris and large particles of uneaten food.
2. Carbon-media vessels are used to remove ozone from solution must be constructed of ozone resistant materials.

B. General Dimensions: The vessels shall be of the capacity and dimensions shown on the Drawings. The heads must be elliptical domes; ASME flanged and dished style heads are not an acceptable substitute. The Fabricator shall be responsible for the design of all shell thicknesses, lap joints, joint details and all other structural detailing.

C. Design Methods:

1. Method 1: The vessel liner, including both heads and side shell, shall be wound with continuous fiber strands.
2. Method 2: Joining multiple subcomponents together by use of the secondary overlay method permitted with the following conditions. Components shall be fabricated over molds. The fabricator shall use special techniques to insure a uniform exterior appearance without excessive undulations.
3. The structural design and construction shall limit strains in any direction to less than 0.001; this strain limitation shall not be exceeded at the specified test pressure. Calculated size and thicknesses of vessel components shall be such that the imposed strain does not exceed the allowable strain for the laminate in the direction of the applied stress with 1.1 times the design pressure.
4. Miscellaneous: For specific methods not covered in this specification, the manufacture shall refer to Section X, ASME Boiler and Pressure Vessel Code, "Fiberglass-Reinforced Plastic Pressure Vessels." Where pressure requirements do not govern, the following references shall be used for design: National Bureau of Standards, Voluntary Product Standard PS 15-69; ASTM Standard Specification D 4097-88; and ANSI/NSF International Standard 50.

D. Positive Design Pressure: The working stress design for the vessels shall be no less than the scheduled pressure and/or the positive pressures specified above for working stress. Design temperature shall be 100 deg F. Vessels shall be designed with a minimum burst pressure factor of safety of 4 to 1. Where the Supplier determines that greater or lesser lap-lengths, or lap-thicknesses, than those indicated on the Drawings are necessary, the larger dimension shall be used. Design pressure shall be 50 psi or 75 psi, as listed on the Filter Schedule on the Drawings, and/or as specified elsewhere.

E. Vacuum Design Pressure: The filter vessel shall be capable of withstanding a negative design pressure of 5" mercury.

F. Environmental Loads: The filter vessels shall be designed to resist toppling from out of plumb loading, piping dynamics, and other probable lateral loads including small area loads of 250 psf for maintenance personnel, ladder loads, or loads when loading sand and gravel.

G. Structural Layer:

1. Typical Water Filtration Vessels: Composite layers required to limit stress and strain shall be fabricated with a premium grade isopthalic polyester or vinyl ester resins. Resins with tensile elongation values greater than six-percent are recommended to limit superficial cracking.
2. Vessels for Oxidized Solutions: Composite layers required to limit stress and strain shall be fabricated with resilient resins, such as Hetron 922 vinyl ester by Ashland Chemical Company, or approved substitute by Dow. Resins with tensile elongation values greater than six-percent are recommended to limit superficial cracking.
3. Material properties shall be in accordance with Article RM-1 of ASME Boiler and Pressure Vessel Code, Section X. In every case, the "actual" properties of the vessel materials shall exceed the "design" values.
4. Corrosion Barrier for Exhibit Filters: The interior vessel surface shall have a non-structural corrosion barrier as follows. Glass reinforced isophthalic or vinyl ester resin, not less than

100 mils thick, consisting of two components. The inner component shall consist of two resin-rich layers reinforced with C veil glass. Do not substitute with Nexus veil glass reinforcing. The two inner layers shall have a total thickness of 10 to 20 mils. The inner component shall be followed by a 90 to 100 mil layer reinforced with chopped-strand mat fibers. Alternately, the manufacturer may offer and equal or superior proven method of liner construction subject to review by the specifying Engineer.

5. Ozone-Resistant Resin Corrosion Barrier Liner for Carbon Media Filters: The interior vessel surface shall have a non-structural corrosion barrier, using a special glass reinforced vinyl ester resin not less than 120 mils thick, as follows. Resin shall be specially formulated and recommended by the resin manufacturer for resistance to oxidation by ozone. The liner may consist of an inner 20 mil thick, resin-rich, C veil, surfacing veil of not less than two laminate layers followed by an interior 100 mil layer reinforced with chopped-strand mat fibers; alternately, the manufacturer may offer and equal or superior proven method of liner construction. The inner surface shall receive special attention to assure optimum performance of the finished laminate. Each vessel shall conform to fabricators quality control procedures for a complete sure and if required shall be heat cured immediately following the fabrication process. The post-fabrication resin cure shall follow the specific recommendations of the resin manufacturer for achieving complete cure for maximum corrosion resistance. The manufacturer shall provide a Certificate of Compliance of Curing for each vessel used for quenching of ozone with carbon media.

H. Attachments: The orientation of attachments must be configured as shown on the Drawings. Securing of ports may be one of the following methods selected by the manufacturer:

1. FRP Lap-Weld: Nozzles attached to the vessel using permanent FRP lap-welds. Attachments to the vessel shall be fabricated with compatible resins or bonded using a mutually compatible resin overlaid with a fiberglass veil prior to joining the assembly to the main vessel.
2. Mechanical Connection: Nozzles attached to the vessel using a mechanical connection with a gasket. This method is only allowed where the thickness of the shell of the vessel is increased, a flat mating surface is provided at the thickened shell, and the design has a proven record of success.

I. Process Port Locations: All vertical style filters 48-inch diameter and larger, shall have the top inlet pipe port centered on the top dome of the filter vessel — no exceptions. Filters less than 48-inch diameter may have all ports located on the side-shell, per the Contract Drawing, or per approved review. The outlet pipe port shall be on the lower portion of the vertical cylinder of the side-shell.

J. Exterior Finish:

1. Quality Requirement: Vessels must have a high-quality exterior finish and overall appearance--irregularities and undulations resulting from hand-laid-up techniques are unacceptable. A resin-rich layer shall be applied over the final structural layer of reinforcement. The minimum acceptable level of workmanship and finish shall conform to requirements of ASTM C 582 "Specification for Contact-Molded RPT Laminates for Corrosion Resistant Equipment." Superficial cracks exceeding 0.010-inch in non-structural fillers are not acceptable. Overspray on finished surfaces is not acceptable. Foreign materials and fabrication debris is not acceptable. Exposed glass and/or frayed ends are not acceptable.
2. Indoor Installations: Indoor installation may be finished with the fabricators selected final finish or topcoat product.
3. Outdoor Installations: Exterior of all filters, at outdoor installations, shall be painted for ultraviolet light protection. Prime with *Carboline* – Sanitile 120, or equal. Finish with a topcoat of *Carboline* "3359 DTMC" Modified Acrylic Terpolmer; or approved water-borne acrylic enamel substitute.

K. Required Appurtenances:

1. Minimum FRP nozzle flange thickness shall be per Table 5, of NBS PS15-69, for the 150 PSI rating. Flange drilling shall be per ANSI 125/150 lb. pattern.
2. Manway(s): The preferred access port is a design using internal pressure to seat the seal of an elliptical port sized for human entry. Bolts nuts and washers shall be of Type 316 stainless steel. Typical gaskets shall be of EPDM rubber.
3. Drain nozzles; with gaskets, and Type 316 stainless steel bolts, nuts, and washers.
4. All other appurtenances indicated on the Drawings.

L. Base Supports:

1. Provide manufactured base supports designed for securing to floor slab, or concrete equipment pad, with anchor bolts.
2. Base shall have a minimum clear dimension between floor slab and face of bottom flange to allow for installation and service of piping beneath the vessel as shown on the project's scale drawings.
3. Base supports may be a tripod design or a cylinder with necessary access ports and shall be of non-metallic construction.

M. Filter Internals:

1. Construction: The internals shall be of a proven design to provide the necessary hydraulic conditions and keep the media in place and stable. Internals shall be made in accordance with the Drawings or reviewed shop drawings.
2. Differential Pressure: Total pressure drop through the filter at maximum backwash flow rate shall not exceed 5 psi when performed in a clean vessel without media installed.
3. Top Openings: Top distributor shall allow passage of one-inch solids.
4. Materials: The top distributor and under drain collector system shall be constructed of FRP and Schedule 80 PVC (or heavier duty). As required for structural strength in areas of increased stress fittings shall be fiberglass wrapped or flocked.
5. Bottom Distribution: Bottom laterals shall consist of slotted piping with machined or precisely molded openings designed to retain all media particles as small as 0.30 mm particle size. Drilled hole openings or retainer screens are not acceptable. Threaded connections shall be cut with a special tap manufactured specifically for machining plastic. Silicone lubricant shall be used when making the tap to prevent laminar tearing of plastic threads. Tapping shall be performed at slow speeds to prevent melting. Alternately, threaded connections for laterals in the lower manifold may be made by bonding or mechanically attaching threaded couplings. The threaded fittings will require the application of Teflon tape and/or PTFE paste when assembled. The connection of the laterals to the main distribution header shall be one of the following options:

    a. Connection Option 1 — Preferred: A structural "truss type" connection pipe through the manifold, with openings for water movement, design to carry bending forces with a truss action, with female couplings at each end for threaded male lateral fittings.
    b. Connection Option 2: A saddle or saddle block fastened to the manifold at each lateral connection to allow for additional threaded grip length. If fabricated with drilled and tapped threads, threaded connections shall be cut as specified above.
    c. Connection Option 3: Where the wall thickness of the manifold can provide a sufficient grip length for drilled and tapped threads, the manifold may be drilled and tapped as described above, and the lateral couplings shall have Type 316 SS male ends with PVC slip-fit female end.

N. Manufacturers: This listing of potential manufacturers shall not compromise the above specified requirements. Regardless of the listing of potential manufactures below, all filter vessels shall

conform to the minimum internal diameters, and vertical straight shell lengths, listed in this specification Section and indicated on the Drawings. See Drawings LS9.03 and LS9.02 and others.

1. *Miami Filter*, Fort Pierce, FL (888) 642-6482 www.miamifilter.com;
2. *Neptune-Benson, Inc.,* Coventry, RI (800) 832-8002 www.neptunebenson.com;
3. *Waterco*, Augusta, GA (706) 793-7291 www.waterco.us.
4. No substitutes.

PART 3 - EXECUTION

3.1 DELIVERY AND CLOSE-OUT PROCEDURES - MANUFACTURER

A. As may be necessary to prevent damage during shipping, the internals shall be shipped from the factory separately of the pressure vessels.

B. The manufacturer shall recommend protection and maintenance required for storage prior to placing in service.

3.2 INSTALLATION – CONTRACTOR

A. Contractor shall not release filter vessels for shipment until pressure testing logs and manufacturer's certified Final Inspection Report has been submitted and reviewed by the specifying engineer.

B. Provide or coordinate with Structural for provision of concrete house-keeping pads, or concrete support piers, as required for leveling.

C. Filter vessels shall be aligned with matching centerlines as shown on the Drawings.

D. Before installation of filter media, filter shall be leveled and bearing support surfaces packed with cement grout.

E. Level vessels with jam nuts off the concrete pad or structural slab. Fill gap between the vessel's base support and the concrete pad/slab with high-strength, non-shrink, dry-packed concrete grout. Torque the anchor bolts as required.

F. If required, install internal piping as shown on the manufacturer's approved shop drawings. Alternately, verify the quantity of laterals provided and installed is correct.

G. Contractor shall inspect and photo document the internals of each filter prior to filling with media.

H. Connect piping after setting and leveling of the filters. Filter face piping shall be supported to prevent any sagging, breakage, or unacceptable loading on the filter connection flanges.

I. Install filter media as specified in Sections 170062, 170063 or 170072 and as indicated on the drawings. Cautiously install gravel and gently work-in around lower distributors taking care to avoid stressing or breaking the internal distributor piping. Carefully install media so as not to damage the integrity of the corrosion barrier.

J. Provide hydraulic startup and functional testing of all filters, including backwashing, and demonstration of normal forward-flow rates as shown on the Drawings, to the Owner's satisfaction.

END OF SECTION

SECTION 170028 - DRUM FILTERS

PART 1 - GENERAL

1.1 USAGE

A. The self-backwashing drum filters, delivered in a modular self-standing housing, are used for particulate filtration of saltwater backwash water from backwashing of sand media filters. Particulates will include animal excrement, organic material, animal hair, feathers, grit, and uneaten food.

1.2 GENERAL

A. Filter drum assembly, tank and all accessories for a completely functional, built with options for saltwater service, and packaged system shall be supplied by the filter manufacturer as specified herein. The General Conditions shall apply to this Section as fully as if repeated herein.

B. Provide filters as indicated on the drawings.

C. Filter performance shall meet or exceed the following:

1. Operational Flow: as scheduled on the Drawings.
2. Designed for high total suspended solids (TSS) loading.
3. Mesh Openings: 30 micron.
4. Minimum Filtration Area: 0.92 m2
5. Hydraulic loading not greater than 5.7 gpm per sq ft of filter screen area.

D. Each filter shall be delivered with a locally installed programable controller. See Part 2 below for controller requirements.

E. In addition to the packaged drum filter, deliver a portable pressure washer as specified below.

F. Package shall include the drum filter and housing with a separate skid-mount for the controller, VFD, and booster pump and associated piping.

1.3 QUALITY ASSURANCE

A. The supplier shall preassemble all components at the factory to ensure proper fit and verify proper operation of mechanical and control components.

B. Testing Laboratory Requirements: Acceptable qualified testing laboratories shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) for Labels on Electrical & Mechanical Equipment. Acceptable listing agencies include Canadian Standards Association (CSA), Intertek Testing Services ITS-ETL, and Underwriters Laboratory (UL). Depending on the “Equipment Category” other testing agencies may be qualified by the State of North Carolina; such as NSF International and other approved research laboratories. The supplier shall be fully responsible for compliance with this requirement. If field approval is necessary to meet listing requirements, it shall be completed without delay to the project and at no additional cost to the Owner.

1.4 COORDINATION

A. The Contractor shall measure and verify all applicable structural dimensions before authorizing shipment from the factory.

B. Contractor shall verify all electrical, plumbing, life support and other trades requiring that interface with the filter screen.

C. Contractor shall verify with the supplier of the drum filter that the water source pressure (City water pressure) is coordinated with the drum filter package requirements. The TDH of the booster pump needs to the City water pressure subtracted from the water-spray pressure requirement of the filter.

D. Coordinate with automated controls system.

E. Contractor shall install piping from sprayer booster pumps, supplied separate of drum filter package, to connection at drum filter. Contractor shall install field wiring from drum filter control panel to level switches

F. The drum filter package is not factory-equipped with a main disconnect switch which must be provided per electrical plans and specifications. Where 120 VAC power is scheduled on the Filter Schedule, a special order may be required for 120 VAC power.

G. Coordinate electrical grounding with grounding requirements defined by the Electrical Engineer for the project. Typically, a ground rod needs to be installed next to the main filter housing.

1.5 FACTORY START-UP ASSISTANCE AND TRAINING

A. Technical Start-Up: Supplier shall provide a minimum of one working day of factory trained technician, to assist in the installation and start-up, and to inspect, calibration and start-up the equipment.

B. Training Seminar: Manufacturer's/supplier’s senior personnel to give complete formal seminar on the fundamentals, routine operation, standard maintenance, and rebuilding instruction demonstrations for the drum filters to the Owner’s operational staff. This seminar shall be separate of the Technical Start-Up assistance. Seminar shall be no less than 6-hours of instruction over a one-day period. Include educational material for six trainees, demonstration of actual components and visual aides. Supplier to contact the specifying engineer, the General Contractor and the Owner prior to arranging dates and times of this seminar.

C. This factory startup assistance and training shall be performed as outlined above. Substitution of training by installing contractor, general contractor, or any non-factory representative is strictly prohibited.

1.6 SUBMITTAL

A. Submit manufacturer’s general information and description of drum filters.

B. Submit operational data for maximum flow, pressure losses, and loading capacity. Submit water flow and pressure requirements for backwashing with a description of automated sequencing, including coordination with other electrical control devices.

C. Dimensional drawing of packaged equipment and list of materials.

D. Electrical power and connection requirements.

E. Submit proof that installed materials will bear approved testing agency listing mark or classification markings.

F. Submit manufacturer's warranty covering items described below.

G. Submit manufacturer's brochure for compact wheeled pressure washer.

H. Factory Affidavit: After completion of the technical startup assistance, and the separate training seminar by the factory representative, the contractor shall submit a letter from the equipment manufacturer/supplier or factory representative summarizing the training and startup. The letter shall state the name of the factory representative who performed the training, the Owners staff in attendance, the duration of technical startup assistance, the duration of training seminar, initial set points for drum filter operations (level, spin speed, spray durations, etc.), and a summary of observations made during review of installation. The letter shall state that the supplier has reviewed all installation requirements, and the drum filter is operating per factory recommendations. This shall be signed by the manufacturer/suppliers senior personnel, and be printed on the company's letterhead.

1.7 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010.

1.8 WARRANTY

A. The manufacture shall warranty the HDPE body, and screen frame, of the drum filter to be free of defects in material and workmanship for 2-years after startup in the water treatment system, or 2-years after Owner acceptance of the units from the installing Contractor, whichever is less.

B. The manufacture shall warranty all components external to the body, filter screens, replicable internal components of the drum filter, booster pump and accessories, to be free of defects in material and workmanship for 1-year after startup in the water treatment system, or 1-year after Owner acceptance of the units from the installing Contractor, whichever is less. The manufacture shall replace any components found defective within the 1-year warranty period.

1.9 SERVICE MANUALS

A. Provide two sets of Operation and Maintenance Manuals for all the supplied equipment. These manuals, at a minimum, shall contain the following:

1. As-Built Drawings as described in the Submittal Package (above).
2. Bill of Materials (Parts Book) with all applicable part numbers listed.
3. Operator's Guide Book detailing operation and maintenance procedures required, including a lubrication and maintenance chart, testing, safety procedures, and adjusting guide.
4. Manufacturers data for all major components, electrical schematic and trouble-shooting guides.

PART 2 - PRODUCTS

2.1 COMPLETE PACKAGE DESIGN & PROCESS DESIGN

A. Project has “Tank Type” filters, which is where the drum is built in a modular water-retaining tank .

B. The manufacture shall furnish the drum filter as a complete package including screen assembly, modular tank and cover, level controls, and all other equipment necessary for a complete functioning filter system.

C. Water filtering by means of straining through a series of micron filter plates attached to a rotating drum frame contained within a water holding tank.

D. As the filter plates collect solids, the drum assembly shall rotate to transport the fouled filter plates out of the fluid stream where spray nozzles located above the rotating drum dislodge the solids to a waste trough. Include a fiberglass or HDPE cover over the drum and tank to completely eliminate loss of water. Include liquid level control, actuated valve, and circuitry for a completely functional automatic backwashing system.

2.2 SYSTEM COMPONENTS

A. Drum Construction: Metal components of the drum, drum plates, and hardware shall be of Type 2205 stainless steel. The sludge tray shall be constructed of HDPE, fiberglass, PVC, or Type 2205 stainless steel. Cast metal parts may be CD4M-Cu stainless steel, or similar duplex stainless steel; if not non-metallic. The rotating drum shall be sealed to prevent bypassing of influent into the filtered water chamber prior to straining through the screens. Provide wheels, with closed bearing housings or a central greasing system, to support the drum for smooth operation with serviceable components for a long-lasting and durable design. The filter drum shall not be less than 16-inch diameter.

B. Tank Housing: The water-containing housing tank shall be self-supporting, HDPE, constructed of non-metallic materials, with matching cover finished in a smooth UV resistant coating.

C. Drum Construction: The rotating drum shall be sealed to prevent bypassing of influent into the filtered water chamber prior to straining through the screens. The drum shall run on wheels, with closed bearing housings, or a central greasing system, to support the drum for smooth operation with serviceable components for a long-lasting and durable design.

D. Materials: All materials shall be selected for warm saltwater service. Where there are options for available materials selections, material with the higher resistance to corrosion by saltwater exposure shall be selected.

1. Tank Housing: The water-containing housing tank shall be self-supporting, HDPE, fiberglass, or other non-metallic materials, with matching cover finished in a smooth UV resistant coating. All fastenings and straps shall be Type 316 stainless steel or better.
2. Internal Drum Frame: The cylindrical drum frame, and end plates, shall be reinforced POM (Polyoxymethylene) / PE with no metal straps. Supports, bearing housings, and internal wetted metal brackets and fasteners shall be Type 2205 SS, Type 316L SS, or Type 316L.
3. Wetted Cast Alloys: Cast metal parts shall be CD4M-Cu stainless steel, or similar duplex stainless steel; if not non-metallic.
4. Internal Wetted Hardware: Cap screws, nuts, washers, jack-screws, and all hardware shall be Type 2205 SS, Titanium, or non-metallic.

5. External Dry Hardware: External dry brackets and fasteners may be Type 316L SS if not the higher alloys specified above for wetted components.
6. Skid-mount: The skid mount for the booster pump and controller shall be of FRP construction with Type 316L fasteners.

E. Coatings: All internal wetted metal parts shall be coated with a clear or translucent corrosion protectant, such as “Prolan Protective Lanolin,” intended by the manufacture for rust prevention on metals in direct contact with marine environments.

F. Sludge Trays: The sludge tray shall be constructed of HDPE, fiberglass, PVC, or Type 2205 stainless steel.

G. Filter Screens: Woven polyester fabric screens shall have 30 micron mesh opening size contained within a molded injected polypropylene grid. Furnish screens in complete preformed panels, which can be individually repaired or replaced. Drum filter panels shall allow for field repair, using patching plugs, without having to replace the entire panel.

H. Motor and Drive: TEFC electric motor. Provide speed reducer to rotate the drum at the proper speed. The drivetrain shall consist of a heavy-duty corrosion resistant chain drive or plastic gear wheels. Finish the motor, motor drive, and other exposed carbon steel components, a superior corrosion-resistant paint followed by a over-coat of Prolan Protective Lanolin coating.

I. Backwash Spray System: The screens shall be cleaned by back-spraying with a spray bar along the length of the drum filter. A collection trough shall discharge backwash water out of the filter, with a pipe connection supplied with the filter, for connection to the sewer. High pressure spray nozzles shall be constructed of durable ceramic, or Type 316 or better stainless steel, for long operational times with minimal maintenance. The package of equipment supplied with the drum filter shall include following in pre-assembled piping for backwash water to the spray jets:

1. Isolation Valve: PVC ball valve or gate valve.
2. Solenoid Valve: Pilot-actuated PVC solenoid valve by Plast-O-Matic, slow-closing solenoid valve by ASCO; or high-quality equal.
3. Strainer: Inline strainer for protection of spray jets.

J. Booster Pump: Package shall be supplied with a skid-mounted booster pump for required back-spray flow and pressure.

K. System Overflow Assembly: The package shall be equipped with a device to overflow such that if, the input flow exceeds the filter capacity, excess water will overflow from influent to effluent side of filter, bypassing filter plates without overflowing outer tank.

L. Internal Weir: Unit shall include a weir for control of minimum water level in the rotating screen chamber.

M. Pipe Connections: Equip with pipe flange or flange-pad fittings, with ASME 125/150 lb. bolt pattern, for all piping connections.

N. Level and Motor Controls: Filters shall be delivered with all controls, sensors, automatic controller, and wiring for necessary routine monitoring, automatic backwashing, and automatic shutdown and warning indications upon detection of equipment failures.

1. Controls to connect to level sensors for initiation of automated functions.
2. Controller shall have a programable controller, with HMI color touch-screen, with intuitive interface for setup and setting of parameters. The controller shall use algorithms to allow drum filter operators to maximize the efficiency of drum filter operation. The system shall

have the capability for dynamic drum screen operations give total suspended solids (TSS) input.

3. Controller shall include optional modes for optimization of filtration and/or water savings. Controller shall allow for modes with continuous screen rotation or static screen filtration mode.
4. The controller shall vary the rotational speed of the drum, using the VFD, for maximization of removal of fine particulate and minimization of backwash water requirements.
5. For water savings, the controller shall include a static screen mode (no rotation) with a reverse rotation on high water level to allow for increased particulate capture without a spray-water wash. After a programmable number of reverse rotations, the controller shall perform a full spray-water wash of the screen, after which the filter shall return the static screen water-saving filtration mode.
6. The controller shall include data logging of control events and alarms
7. An Ethernet connection port shall be provided for connection to the LSS ACS for remote/external on/off control, run status, remote activation of backwash, and signaling of alarm conditions.
8. Provide automated controls associated with two level sensors. One level sensor shall be used for start of backwash sequencing. A second level sensor shall be for overflowing alarm. Level sensors shall be submersible pressure level transmitters, such as “HLS Series” by *Hayward,* or equal.
9. Automated control for solenoid valve to supply backwash water to the spray bar. For backwash water from a domestic potable water source, shall be a “slow closing” stainless steel solenoid valve by ASCO, or equal. For saltwater backwash water, shall be “pilot actuated” PVC solenoid valve by Plast-O-Matic, or equal.

O. Electrical Power Connections: Equip filter skid with U.L. approved electrical junction boxes for power connections. All wiring shall be enclosed in corrosion-resistant conduit (exposed wires are not acceptable).

2.3 SPARE PARTS

A. Manufacturer shall deliver each unit with the following replacement spare parts, for each unit delivered:

1. (10) Ten spray jet nozzles.
2. (1) One spare screen panel.
3. (20) twenty screen patching plugs.
4. (1) One Elastomer Drum Seal.

2.4 MANUFACTURER

A. Base Manufacturer: The Drawings and specification are based on products available from the following manufacturer:

1. CM Aqua, HEX “X” Series Supplied by *Integrated Aqua Systems* (760) 745-2201 www.integrated-aqua.com;

B. Alternate Manufacturers: This listing of potential manufacturers shall not compromise the above specified requirements and may require the Contactor to make adjustments in pipe routing from what is shown on the Drawings:

1. PRAqua Supplies, Ltd. Nanaimo, B.C., Canada, (250) 754-4844 www.praqua.com;

2. Supplied by Aquatic Eco-Systems, Apopka, FL.

2.5 COMPACT WASHER

A. Compact Wheeled Pressure Washer: Provide a compact wheeled pressure washer with delivery of drum filter(s). Equipped with four wheeled chassis with two swivel casters for ease of transporting.

1. 1800psi +/- 200 psi spray at 1.0 to 1.5 gallons per minute.
2. Onboard detergent tank.
3. Equipped with a long power cord and a 30-foot minimum length high pressure hose.

B. Manufacture:

1. Karcher;
2. *Southern Environmental* 128 Park Center Street Leesburg,FL 34748 (352) 360-0036 www.seelsbg.com;
3. Or substitute.

PART 3 - EXECUTION

3.1 INSTALLATION - CONTRACTOR

A. The Contractor shall install the equipment as specified herein, as recommended by manufacturer, and as shown on the drawings and make all necessary connections or adjustments for a complete and correct installation.

B. Coordinate installation of gravity discharge pipe with outlet on filter sump. Arrange pipe elevations to maximize the slope of the pipe from the connection at the filter to the pipes downstream elevation.

C. Connecting piping shall commence only after setting and leveling of the filters.

D. Install field wiring from drum filter control panel to level switches.

E. Contractor shall ensure electrical equipment is in conformance with a approved testing laboratory listing and bears certification labeling.

F. Install piping from sprayer booster pumps to connection at drum filter and install field wiring from drum filter control panel to level switches.

G. Complete installation of electrical grounding of the drum filter and verify grounding connects to the internal wetted drum frame.

H. Connect the local automated controller(s) to the LSS Automated Controls System (ACS).

I. Contractor shall make arrangements for technical startup assistance, and an Owners technical training seminar, by the drum filter factory representative/supplier. Contractor shall deliver a

"Factory Affidavit" of the startup and training seminar as further described under the Submittals section above.

J. Deliver spare parts to the Owner, including one complete specified set per installed filter.

K. Deliver one (1) compact pressure washer for the project.

L. Demonstrate drum filter operations to the satisfaction of the Owner.

END OF SECTION

SECTION 170032 - BAG FILTERS

PART 1 - GENERA

1.1 USAGE

A. The bag filters are used for filtration of saltwater aquarium water.

B. Spare Filter Bags: Provide one spare filter bag, in addition to each installed filter bag, for each installed filter vessel.

1.2 SUMMARY

A. Bag filters, and hanger supports, as specified herein.

1.3 SUBMITTALS

A. Submit product data on filtering elements, all materials of construction, dimensional drawings, and list of any custom materials.

1.4 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010.

PART 2 - PRODUCTS

2.1 PRESSURE VESSEL & BAG FILTER

A. Housing: Over the top design custom fabricated for use with sea water with all liquid contacting components of non-metallic materials. Manufactured for use with 7-inch by 32-inch industry standard filter bag.

B. Connections: 2-inch diameter flanged ports with ASME 150 lb. bolt pattern. 0.75-inch gauge ports at up and downstream locations.

C. Pressure Testing: Strength of each model shall be proven by factory pressure testing to no less than 75 psi.

D. Bag Filters: Suitable for use with sea water. 7-inch by 32-inch in dimension and containing approximately 30 square foot aggregate or 4 square foot projected of filter media. Filter of polypropylene. Bag ring and bottom clamp of polypropylene or titanium (custom materials).

E. Supplier:

1. Hayward Flow Control, Clemmons, NC (888) 429-4635, www.haywardflowcontrol.com;
2. Aquatic Eco-Systems, Apopka, FL;
3. Or approved substitute

2.2 BAG FILTERS AND HANGERS

A. Design: Drop-in type bag filters for use with saltwater with bag ring and bottom clamp.

B. Bag Filters: 7-inch by 32-inch needled-felt polypropylene filter bag containing approximately 30-square foot aggregate or 4-square foot projected of filter media.

C. Performance: Efficiency in removal of 10-micron particles shall exceed 99% when operated at 16 GPM. Pressure drop at 16 GPM shall be less than 0.4 PSI and or functional for the hanger type installation.

D. Supports: Designed to securely support the drop-in filter bags matching requirements of the installed situation. Bag ring and bottom clamp of polypropylene or titanium.

E. Suppliers:

1. *3M* brand bag filters;
2. *Hayward Flow Control*, Clemmons, NC (888) 429-4635, www.haywardflowcontrol.com;
3. *Aquatic Eco-Systems*, Apopka, FL;
4. or approved substitute.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in location(s) shown on the drawings. Exercise care during installation so permanent stresses are not imposed on the filter units from the connecting piping. Arrange overhead clearance for entry of filter bag without obstruction.

B. For hanging filter bags, provide and install racks, matching the size of rings at the open end of the filter bags.

C. Deliver backup stock of bag filter element(s) to the Owner/Representative in individual protective cartons.

END OF SECTION

CARTRIDGE FILTERS - SECTION 170035

PART 1 - GENERAL

1.1 USAGE

A. Tag No. LCR-FGN001-001 Live Coral Flexible Cartridge Filter Housing. Housing provided and installed by Contractor. Inner filter element provided and installed by Owner.

B. Tag No. HTT-FCRT01-001 Holding Touch Tank / Carbon Cartridge Filter. Housing and filter element provided and installed by Contractor.

1.2 SUMMARY

A. Complete cartridge filter unit shall be supplied as specified herein. The size and location of all units shall be as indicated on the drawings. The General Conditions shall apply to this Section as fully as if repeated herein.

B. One complete set of replacement cartridge elements for each filter unit installed shall be provided to the Owner upon completion of the project. Applies to Tag No. HTT-FCRT01-001.

1.3 SUBMITTALS

A. Submit product data on cartridge filtering elements, all materials of construction, and dimensional Drawings.

1.4 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010.

PART 2 - PRODUCTS

2.1 FILTER HOUSINGS

A. Polycarbonate housing with stainless steel swing bolts for securing top cover. Manufactured to function in a pressurized water system with a maximum working pressure of 125 psi. 2-inch port connections and rated at 15 gpm or more with carbon media filtration with a pressure loss less than 5.0 psi. Width of 12-inch O.D. and overall height of 40-inch.

B. Materials: Glass reinforced PP housing and cap, Type 304 or Type 316 stainless steel swing bolts, and EPDM O-rings. No brass parts.

C. Model and Manufacturer: Model BBH-150-NP , “Big Bubba” filter by *Watts Water Technologies* (800) 659-8400 www.watts.com

2.2 INTERNAL FILTER ELEMENT

A. Carbon media shall be supplied in an encapsulated cartridge. The cartridge shall have the ability to withstand a 30 psi differential pressure without loss of carbon media. The cylindrical cartridge 7-inch by 31-inch with 5 micron particulate filtration rating. Activated carbon rated for 90% chlorine reduction.

B. Cartridge with activated carbon by *Watts Water Technologies* (800) 659-8400 www.watts.com.

PART 3 -

PART 4 - EXECUTION

4.1 INSTALLATION

A. Filter units shall be installed in the locations shown on the drawings. Provide a level concrete housekeeping pad as necessary or as indicated on the Drawings.

B. Exercise care during installation so permanent stresses are not imposed on the filter units from the connecting piping. Anchor vessels to floor slab with fasteners per Section 170316. Complete installation per manufactures recommendations.

C. Supply backup cartridge element, for Tag No. HTT-FCRT01-001, to the Owner's representative in protective carton.

END OF SECTION

SECTION 170062 - SAND FILTER MEDIA

PART 1 - GENERAL

1.1 USAGE

A. For installation in pressure vessel filters as follows:

1. Support media, with #20 fine sand top layer, per this specification Section.
2. Support media per this specification Section with Glass top layer per specification Section 170063.
3. Support media per this specification Section with Carbon top layer per specification Section 170072.

1.2 GENERAL & QUALITY CONTROL

A. Stratification for the various types of filter media shall be as indicated on the Drawings. The General Conditions shall apply to this Section as fully as if repeated herein.

B. All filter media shall be supplied specifically for use in granular filters. The media supplier shall have a history of supplying filter sand for similar applications.

C. The supplier shall be responsible for maintaining quality control of the product from selection of the quarry source through delivery. Sampling, inspection and testing shall be in accordance with Federal Specification SS-C744a, the ASCE Manual of Engineering Practice No. 13 "Standard for Filtering Material," and AWWA B 100 Standard for Filter Material.

D. Soundness testing of representative quarry material may include but not be limited to the following:

1. The sodium sulfate soundness test for any signs of disintegration, cracking, flaking, checking, splitting, or crumbling. The loss of material from original rock pieces shall not exceed 5-percent after twenty (20) cycles of the test (see ASCE Manual of Engineering Practice No. 13).
2. Testing for hardness, toughness, wear, and compression strength.

E. Contractor shall be responsible for complete installation of all media as described below.

1.3 REFERENCED STANDARDS

A. The following standards shall be referenced for definitions of terminology used in this specification and testing and sampling methods:

1. AWWA Designation B100 Standard for Filtering Material.
2. ASCE Manual of Engineering Practice No. 13 "Standard for Filtering Material."
3. Federal Specification SS-C744a.
4. American Petroleum Institute (API) Recommended Practices for Testing Sand Used in Hydraulic Fracturing Operations, document API RP 56.

1.4 SUBMITTALS

A. Submit sieve analysis and a graphic plot of the grain size distribution for all sands.

B. Provide the following data for all sand and gravel:

1. Effective grain sizes for all sands.
2. Typical dimensions of gravels.
3. Uniformity coefficients for all sands.
4. Description of rock type or geology of quarry.
5. Sphericity and roundness or angularity.
6. Percent fines passing No. 200 sieve.

C. Submit to the Engineer for approval samples of each type and grade of media to be provided. Samples shall be placed in properly labeled, sealed containers holding not less than one pound each. The filter media delivered to the site shall equal in all respects to the approved samples. Media for installation shall not be shipped to the site prior to approval of samples.

D. Upon the specific request of the Engineer for this project submit: source of material, hardness, density, sodium sulfate soundness testing of quarry material, acid solubility testing of graded material, or other descriptive data. This additional information is usually only necessary if proposed sample are suspected as substandard.

PART 2 - PRODUCTS

2.1 GENERAL MATERIALS

A. Angularity, sphericity and roundness shall be determined using Chart for Visual Estimation of Sphericity and Roundness Frac Sand Sphericity and Roundness, Fig. 5.1 API Recommended Practices for Testing Sand Used in Hydraulic Fracturing Operations. The original chart for estimation of sphericity and roundness is given in Stratigraphy and Sedimentation, Second Edition, Krumbein, W.C. and Sloss, L.L., Copyright 1963 by W.H. Freeman and Co., New York, N.Y. (a.k.a. the Krumbine Roundness chart.)

B. All media shall be free from any significant amounts of iron or manganese compounds.

2.2 SUPPORT GRAVEL

A. Shape of gravels shall be generally spherical or equidimensional. Shall have a roundness of 0.4 or greater and a sphericity greater than 0.5. Not more than 25-percent by weight shall have more than one fractured face; refer to AWWA B-100. Support gravel with sharp points and/or edges is not acceptable.

B. All gravel shall consist of hard and durable inert rock. Specific gravity not less than 2.60. Indurated rock which fractures along sedimentary striation planes or crumbles under impact is not acceptable.

C. Shall not contain more than 2-percent thin, flat or elongated pieces as defined by having a sphericity of 0.3 or less. Shall not contain a total of more than 1-percent loam, clay, sand, shells, dirt and organic impurities or other foreign matter.

D. Acid solubility of gravels shall be not more than 10-percent when tested in accordance with Section A2.2 of AWWA Standard B100 or methods given in Section 6 of the API reference.

2.3 SUPPORT SAND MEDIA

A. Shape of support sand media shall be generally spherical or equidimensional. Support sand may be round or angular with a sphericity of 0.7 or greater.

B. Support sand is defined as the strata above 3/8 inch pea gravel and below the top media layer. Support sand shall consist of hard, durable and inert particles with no less than 90% silica dioxide content. Total quartz no less than 85% and total feldspar no greater than 15%. Average specific gravity not less than 2.60.

C. Gradation of supporting sand shall be as follows:

Media Size	Effective Grain Size	Uniformity Coefficient	Comment
#16 Supporting Sand	0.59 mm to 0.71mm	1.6 maximum	Equidimensional
#10 Supporting Media	1.5 mm to 2.0mm	2.0 maximum	Needs to be clean

D. Shall not contain more than 2-percent thin, flat or elongated pieces as defined by having a sphericity of 0.3 or less. Shall not contain loam, clay, sand, shells, organic impurities or other foreign matter.

E. Acid solubility of gravels shall be not more than 5-percent when tested per Section A2.2 of AWWA Standard B100 or methods given in Section 6 of the API reference.

2.4 TOP FILTER SAND MEDIA

A. The top layer of fine sand shall consist of angular particles manufactured from crushed rock. Shall have a roundness of 0.5 or less and a sphericity greater than 0.5. Round and uniform size fine filter sand is not acceptable.

B. Gradation of the top layer of fine sand shall be as follows:

Media Type	Effective Grain Size	Uniformity Coefficient	Comment
Typical Fine Media, #20	0.45mm to 0.55mm	1.35 to 1.70	Angular

C. Fine media shall consist of hard, durable, dense silica sand, resistant to degradation during handling and backwashing, with an average specific density of 2.62 or greater. Total quartz no less than 60% and total feldspar no greater than 35%. Rock types other than quartz and feldspar shall not exceed 5%.

D. Shall not contain any visible loam, clay, dust, shells, organic impurities or other foreign matter. Material passing No. 200 sieve (0.074mm) shall not exceed 2-percent by weight. Shall not contain more than 5-percent dark particles by count. Shall not contain more than 5-percent flat particles (material with a sphericity of 0.3 or less).

E. Acid solubility of sands shall be not more than 5-percent. A two gram sample of the sand, crushed and powdered to pass a 50 mesh screen and digested without stirring in ten milliliters of 40% hydrochloric acid at a temperature of 65-75 deg F for 24 hours, shall not show a loss of weight greater than five percent. See also acid solubility test in AWWA B 100.

F. Sand and Gravel Supplies: The following suppliers are for reference and this listing does not connotate product approval.

1. Best Sand Corporation Chardon, OH (440) 285-3132 www.fairmountminerals.com;
2. Holliston Sand Company, Inc. Slatersville, RI (401) 766-3144 www.hollistonsand.com;
3. Northern Gravel Co. Muscatine, IO (319) 263-2711;
4. Oglebay Norton Industrial Sands Colorado Springs, CO (719) 390-7969;
5. Red Flint Sand and Gravel Eau Claire, WI (800) 238-9139 www.redflint.com;
6. Ricci Brothers Port Norris, NJ (856) 785-0166 www.riccisand.com;
7. Standard Sand and Silica Miami, FL (954) 574-5322 or (877) 444-7263 www.standardsand.com;
8. U.S. Silica Berkeley Springs, WV (800) 257-7034 u-s-silica.com.

2.5 TOP FILTER GLASS MEDIA

A. See specification Section 170063.

2.6 TOP FILTER CARBON MEDIA

A. See specification Section 170072.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Storage: Media shall be stored in places protected from the weather and shall not be deposited directly on the ground.

B. Preparation of Filters: Before placing the gravel, the Contractor shall determine that all holes in the underdrain system are open and free of debris. Before placing any media, the filter piping must be complete and necessary hydraulic connections must be in place for backwashing of filters. Immediately prior to placement of any media in a filter, the Owner's Representative shall be given the opportunity to inspect each filter internally.

C. Placing Filter Media: Install each layer up to the required elevation, make level over the entire filter bed area, and smooth to a true surface. In placing each successive layer of media, extreme care shall be taken to avoid disturbing the previous layer.

D. Special Backwashing: If layers are suspected to contain excessive fine or dirty materials, then the intermediate layer shall be backwashed before beginning the placement of the next size.

Fine-grained materials which accumulate at the surface of the bed shall be scraped off and removed after each backwashing.

3.2 INSTALLATION OF GRAVEL AND SUPPORT SAND LAYERS

A. Required Initial Backwash: The empty filters shall be backwashed at no less than the standard backwash rate and drained prior to placing gravel.

1. The filter shall be checked for proper water flow, and/or excessive pressure drop, at the time of initial backwashing.
2. Following the initial backwashing of the empty filter, the top hatches shall be open and the condition of the lower laterals shall be visually inspected.

B. Care shall be taken when depositing media as to avoid damaging the distributor piping. It is very important that the gravel surrounding the lower filter distributor does not contain fine material.

C. Particular attention must be given to prevent finer particulate and sand from working into the gravel and clogging the filter's lower distributor slots.

3.3 INSTALLATION OF TOP SAND LAYER

A. Care shall be taken in transporting and placing the sand to keep the sand clean. Any sand which may have become dirty, either before or after it has been placed in the filters, shall be either washed or removed and replaced by clean media. All sand contaminated by organic matter will be rejected.

B. Unless indicated otherwise on the drawings, install sufficient quantity of top fine media to fill two-thirds of the space between the preceding support sand and the top distributor port.

C. Washing Sand Media: Filters shall be backwashed after installation media. Take care to admit water slowly so that the air can be released gradually as the water fills the tank. Wash-water applied at the start at a rate not to exceed two gallons per minute per square foot of filter area and shall be gradually increased to the rate given on the Piping & Instrumentation Diagrams rate for not less than a 5-minute duration. In the case where additional scouring is determined necessary, the filtration sand bed shall be backwashed at a rate of 18 gallons per minute per square foot.

D. After backwashing, open the access manhole and check level of media, top-off the final layer as necessary, and backwash once more. Fine-grained materials which accumulate at the surface of the bed shall be scraped off and removed after each backwashing.

END OF SECTION

SECTION 170063 - GLASS FILTER MEDIA

PART 1 - GENERAL

A. SEE SPECIFICATION SECTION 170062.

PART 2 - PRODUCTS

2.1 GENERAL MATERIALS

A. SEE SPECIFICATION SECTION 170062.

2.2 SUPPORT SAND MEDIA

A. SEE SPECIFICATION SECTION 170062.

2.3 TOP CRUSHED GLASS FILTER MEDIA

A. The top layer shall consist of post-industrial glass processed through a series of crushers, dryers, and screens to remove contaminants and to produce a range of uniformly sized filtration media. The post-industrial glass shall be completely free of the potential organic (sugars, labels, etc.) and inorganic (aluminum rings, steel caps, etc.) contamination.

B. Media shall not be sourced from general recycled glass.

C. Shall have an “angular-subangular” roundness and a sphericity greater than 0.3.

D. Gradation of the top layer of crushed glass shall be as follows:

E. Crushed glass media shall an average specific density of 2.55 or less.

Media Type	Effective Grain Size	Uniformity Coefficient	Comment
Top Crushed Glass	0.45 mm to 0.55	1.35 to 1.7	Angular

F. Crushed glass media suppliers: The following suppliers are for reference and this listing does not connotate product approval.

1. Lincoln Equipment, Inc. P.O. Box 20134 Portland OR, contact Mark Dernedde (800) 223-5450 x 106 mdernedde@lincolnaquatics.com;
2. Trivitro Corporation Seattle, WA, telephone (360) 733-2122;
3. Or approved substitute.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. See also specification Section 1700062 for support sand and gravel.

B. Placing Crushed Glass Filter Media: Install crushed glass up to the required elevation, make level over the entire filter bed area, and smooth to a true surface. Unless indicated otherwise on the drawings, install sufficient quantity of top fine media to fill two-thirds of the space between the preceding support sand and the top distributor port.

C. After backwashing the top layer, open the access manhole and check level of media, top-off the final layer as necessary, and backwash once more. Fine-grained materials which accumulate at the surface of the bed shall be scraped off and removed after each backwashing.

END OF SECTION

SECTION 170072 - CARBON MEDIA

PART 1 - GENERAL

1.1 USAGE

A. The project has the following types of applications:

1. Incoming water filters loaded with Carbon Media.
2. Pressure filters for quenching of dissolved ozone loaded with carbon media.

1.2 GENERAL MATERIALS

A. SEE SPECIFICATION SECTION 170062.

1.3 SUPPORT SAND MEDIA

A. SEE SPECIFICATION SECTION 170062.

1.4 QUALITY CONTROL

A. The quantity and depth shall be as indicated on the Drawings.

B. All media shall be shall specifically recommended by the supplier for use in water treatment.

1.5 SUBMITTALS

A. Submit the following information for GAC Carbon Media:

1. Manufacturer’s detailed technical information on the product.
2. Iodine Number (mg/g).
3. Mesh size, % greater than & % less than (U.S. Sieve).
4. Mean particle size.
5. Apparent density (g/cc and/or lbs./ft3).
6. Mono-chloramine removal efficiency where used for de-chlorination.
7. Compliancy Standards

PART 2 - PRODUCTS

2.1 GAC CARBON MEDIA (Coconut Shell)

A. Manufacturer’s Recommendations: A catalytic GAC specifically recommended by the manufacturer for de-ozonation or chloramine removal. Where used for treatment of incoming City water, the GAC shall be “surface activated” and capable of removing a minimum of 75% monochloramine with a 10-minute contact time.

B. Product Description: Activated carbon derived from coconut shells manufactured by high heat activation. Substitution with a product derived from coal is not acceptable.

1. Iodine Number: 975 mg/g minimum per ASTM D4607.
2. Size: Grade 20 x 50 mesh size preferred, 12 x 40 option is acceptable.
3. Apparent Density: 0.49 to 0.60 g/cc per ASTM D2854.
4. Ash: 2% maximum per ASTM D2866.

C. Standards: Shall meet standards of Food Chemical Codex, comply with AWWA B604- 9 specifications, and have NSF and WQA Gold Seal certification. Or shall meet AWWA Standards, certified for ANSI/NSF Standard 61, and Prop 65 compliant for drinking water applications.

D. Cleanliness: Supplied pre-moistened and acid washed to eliminate dust and have very low fines. Shall be a premium grade product having superior adsorption properties.

E. Product and Suppliers:

1. AGC-50 CSAW, by *Resintech, Inc*., West Berlin, NJ (856) 768-9600 www.resintech.com;
2. *American Activated Carbon Corp*., Canoga Park, CA (310) 491-2842 www.aacarbon.com;
3. *Carbon Activated Corp*., Compton, CA (310) 885-4555 www.activatedcarbon.com;
4. GAC-2050-S Spartan Series by *PureWater* (866) 535-5092 www.purewatersite.com;
5. Approved Substitute.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Support Media: Install supporting gravel media as specified in Section 170062.

B. Storage: Media shall be stored in places protected from the weather and shall not be deposited directly on the ground.

C. Safety & Health: Special care must be taken in transporting and storage of the carbon media/GAC to ensure that the containers are kept completely sealed until their use. In addition, wet activated carbon removes oxygen from air. In closed or partially closed spaces, oxygen depletion may reach hazardous levels. Appropriate sampling and work procedures for low-oxygen spaces should be followed. Adhere to all manufacturer's safety recommendations and MSDS information.

D. Special Handling: Take special care not to handle media in a manner which may result in the creation of fine particles and dust.

E. Washing Media: At the time of installation, thoroughly wash media the media to remove all fine material and dust, prior to final placement.

END OF SECTION

SECTION 170088 - PACKING & DRIFT ELIMINATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide packing where indicated on the drawings and as specified herein where “Packing” is call for in the Deaeration Towers and Biotowers.

1. Structural packing to be installed in deaeration towers.
2. Random packing to be installed in biomedia chambers.

B. Provide protective grid on top surface of structured packing.

C. Provide drift eliminators where indicated on the Drawings.

1.2 COORDINATION

A. Coordinate with as-built dimensions of deaeration towers before cutting structured packing to finished dimensions. Allow ¼-inch clearance between the vessel wall and packing to facilitate installation and removal.

1.3 SUBMITTALS

A. Random Packing: Submit description of random packing. Submit sample of media for review. Do not ship media to jobsite prior to review. Media delivered to the jobsite shall be equal in all respects to the sample.

B. Structured Packing:

1. Submit general description of structured packing and detailed data on dimensions and material properties of selected product.
2. Submit information on protective grid.
3. Submit dimensions and layout of structured packing coordinated with other components of the tower including, but not limited to: piping, supports, tower risers and distributors. Sizes of individual units shall be coordinated with access restrictions, size of hatches, and other dimensions indicated in the Drawings.

C. Cellular Drift Eliminators: Submit general description of drift eliminators and specific dimensions of selected product.

PART 2 - PRODUCTS

2.1 RANDOM BIOMEDIA

A. Usage: Used in filtered aquarium saltwater trickling chambers for the purpose of nitrification reducing entrained bubbles. Biomedia packing with plastic elements for a maximum

impingement of flow. Packing shall consist of a single rigid molded piece. Assemblies requiring attachment clips are not allowed.

1. Void space in excess of 93%.
2. Specific surface area in excess of 48 ft2/ ft3.
3. Size: 2-inch.
4. Material: Packing shall be of clean PP (Polypropylene) castings, free of any excessive flashing, resilient and not susceptible to breakage when dropped on concrete from a height of 25 feet. Tough virgin plastic resin construction, not containing any re-grind resins.

B. Manufacturers:

1. *Koch Engineering Company Inc.* (FLEXIRING media) Buena Park, CA (714) 739-8853;
2. *Lantec Products Inc*., Agoura Hills, CA (818) 707-2285;
3. *Norton Company* (Plastic Pall-Ring media) Anaheim, CA (714) 970-3000;
4. *Lee's Aquarium & Pet Products* (Bio-Pinball media) San Marcos, CA (619) 744-8230;
5. *RK2 Systems Inc.* (Bio-Pinball media);
6. *Glitsch Inc*. (Plastic Ballast Ring) Dallas, TX (214) 631-3841;
7. *Aeration Engineering Resources Corporation* (AERCOR ACTIFIL media) Worcester, MA (508) 756-1020;
8. *Jaeger Product Inc.* (Plastic Nor-Pac media) Spring, TX (713) 444-9500.

2.2 STRUCTURED TOWER PACKING MEDIA AND PROTECTIVE GRID

A. Structured Packing: To be used in Deaeration chambers for the purpose of reducing entrained bubbles and may be used for biological filtration at aquarium facilities. Packing shall be designed for the purpose of scrubbing and air stripping with cross-corrugated plastic sheets for a maximum impingement of flow.

1. Void space in excess of 95%.
2. Specific surface area in excess of 67 ft2/ ft3.
3. Corrugation angle of 30 deg .
4. Sheets/ft. = 26.
5. Mixing and redistribution points in excess of 2,400/ft3.
6. Sheet thickness of 10 mil for indoor installations, 10 mil for outdoor installations.
7. Height of packing layers may vary from 11.8-inch to 12-inch.
8. Brentwood CF 1200 or substitute.

B. Overall Dimensions: As called for on the drawings with the following exception. The unit dimensions may be maximized for economy, as recommended by the Manufacturer for the specific application and dimensions of tower and supports; however, the depth of packing shall be at least two (2) layers placed perpendicular to each other. Packing units shall be custom trimmed for circular towers, piping, supports, tower risers and distributors.

C. Material and Properties: Packing shall be of clean PVC sheet moldings, free of any excessive flashing, trimmings, solvents or un-cured glues. Material properties shall conform to the specification in CTI STD 136 and as listed below:

1. Tensile Strength: 5,500 psi minimum average value per ASTM D638/D882.
2. Elastic Modulus: 350,000 psi minimum average value per ASTM D638/D882.
3. Flexural Strength: 10,000 psi minimum average value per ASTM D790.
4. Flexural Modulus: 350,000 psi minimum average value per ASTM D790.
5. Impact Resistance: 1.2 in-lbs/mil thickness per ASTM D4226.

6. Heat Distortion: 160 deg Fahrenheit minimum per ASTM D648.

D. Protective Grid: U.V. stabilized black polypropylene 2" x 2" grid, 1.25-thickness, designed for installation on top of structured tower to avoid damage from walking and hydraulic impact.

E. Manufacturer:

1. ACCU-PAC and AccuGrid manufactured by *Brentwood Industries Inc*. and available from *L S Enterprises LLC*, East Earl, PA (239) 851-1175 or (717) 351-3933 www.biofilters.com;
2. Or approved substitute.

2.3 CELLULAR TYPE DRIFT ELIMINATORS

A. Cellular type drift eliminator designed to remove entrained water droplets from the leaving air stream at minimum pressure loss. Fabricated from rigid, corrugated PVC (or CPVC) sheets conforming to ASTM D 1784. The mass drift quantity shall be determined by the CTI STD-140 HBIK drift test Code, or the EPA method 13 A system of analysis, and the drift quantity/loss shall not exceed 0.0005% recirculation.

B. Manufactured to be field-cut, for tight fit, without sacrificing structural integrity.

C. The eliminators shall be the cellular type with end caps to provide extra structural integrity for beam strength and durability.

1. Unit Depth: 5.25-inch.
2. Cell Size: 0.86-inch. 0.80-inch to 1-inch for alternate manufacturers.
3. Material Gauge: 13 mil (0.33mm) thickness for up to 4-ft span. 20 mil (0.51mm) heavy duty thickness for up to 6-span. May be 15 mil thickness for spans up to 5-ft where available from alternate manufacturers.

D. Base Model and Manufacturer:

1. Models CFUltra or CF80Max by *Brentwood Industries Inc.* www.brentwoodindustries.com and available from *L.S. Enterprises* Gainesville, FL (352) 379-5626 www.biofilters.com;

E. Other Manufacturers which may or may not meet specified requirements:

1. *Koch-Glitsch Wichita*, KS (888) 562-4911 www.koch-glitsch.com;
2. *Sulzer Chemtech USA Inc*. Humble, TX www.sulzer.com.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Contractor shall take responsibility for damage to packing, dimensions of packing units and fit through openings and around piping, supports, tower riser, distributors and as required for installation.

B. Random Biomedia:

1. Compare each load to an acceptable sample; do not load any media exhibiting excessive molding-flashings, broken pieces or otherwise below quality of specified material.
2. Place by dumping in a manner that avoids breakage and refrain from dropping from heights. Place randomly to required height indicated on drawings and rake for a uniform final surface level.

C. Structured Packing:

1. Place packing in at least two (2) layers aligned perpendicular to each other.
2. Allow approximately ¼-inch clearance between the vessel wall and packing to facilitate installation and removal.
3. Trimmings, shavings or other pieces of packing shall be completely removed from the packing and the tower prior to filling the system with water.
4. Install protective grid over top of last layer of packing.

D. Protective Grid: Install a covering of the Protective Grid over the packing segments cut in plan arrangements to avoid alignment of gaps in the packing with seams of the Protective Grid.

E. Drift Eliminators: The drift modules shall be installed as per manufacturer's recommendations.

1. The drift modules shall be carefully cut or trimmed to fit within 1/4 inch (or less) of any obstruction or sidewall to prevent air bypass. The shaping, cutting and trimming of the drift modules may be done in the tower provided that precaution is taken by the Contractor to prevent any chips, broken pieces, or debris from falling into the media and caution that the cutting may weaken the structural integrity of the product.
2. The drift modules shall be placed in the tower to provide the closest possible fit with adjacent modules without damaging the modules.
3. Drift modules shall be installed such that the sheets of all modules are perpendicular to the support beams and/or in alignment with seams of supporting FRP grate.
4. The drift modules are not intended to have workmen walking on them. To prevent damage or injury, the contractor shall use plywood or other suitable temporary planking.
5. Final installations where foot traffic may be required shall have a protective grid installed over the drift modules.

END OF SECTION

SECTION 170107 - CURRENT EFFECTS GENERATORS

PART 1 - GENERAL

1.1 USAGE

A. Used in the Live Coral and Sand Shark saltwater aquarium tanks to boost water circulation.

1.2 QUALITY ASSURANCE

A. Pumps and motors shall be preassembled at the factory to ensure quality control and quality assurance.

B. Testing Laboratory Requirements: Acceptable qualified testing laboratories shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) for Labels on Electrical & Mechanical Equipment. Acceptable listing agencies include Canadian Standards Association (CSA), Intertek Testing Services ITS-ETL, and Underwriters Laboratory (UL). The supplier/ manufacturer shall be fully responsible for compliance with this requirement. If field approval is necessary to meet listing requirements, it shall be completed without delay to the project and at no additional cost to the Owner.

1.3 COORDINATION

A. Refer to Exhibit Design drawings for integration into the thematic setting. Coordinate exact installed locations with Aquarium operational staff at the time of installation.

B. Coordinate required mounts with selected model and tank locations. Use available magnet mounting as required; however, the stability of the magnetic mount may not be possible through thick tank walls and require additional in-tank mounts.

C. Coordinate length of factory available power cord with electrical power.

D. Coordinate dry location for installation of controller with environmental conditions.

E. Coordinate secondary grounding for generator unit housing to building grounding with electrical.

1.4 SUBMITTALS

A. Submit the following items:

1. Manufacturer’s brochure information including indication of model number and selected materials.
2. Submit manufacturer’s grounding lug for connection from generator unit housing to building grounding.
3. Submit proof that installed materials will bear testing agency listing mark or classification markings.
4. Submit manufacturer’s installation instructions, for review, prior to approval.

1.5 WARRANTY

A. The manufacture or supplier shall warranty products to be free of defects in material and workmanship, and perform as specified, for 1-year after startup in the water treatment system, or 1-year after Owner acceptance of the units from the installing Contractor, whichever is less. The manufacture or supplier shall replace or repair products found defective within the 1-year warranty period.

PART 2 - PRODUCTS

2.1 CURRENT EFFECTS GENERATORS

A. Propeller type mixer specially designed for installing in an aquarium tank and moving large volumes of water. The intake shall have a surface area four times greater than the exit with water streaming into the pump at a maximum of 3 feet per second. The mixer shall produce a non-rotating current with a maximum exit velocity approximately 11 feet per second.

B. In the submerged condition, the pump shall produce maximum flow of 160,000 L/hour or more.

C. Electric motor shall be built for submersible operation with a variable speed range from zero to 100% RPM.

D. Provided with mounting lugs for securing the unit into a wide range of mounting positions.

E. All wetted components of plastic or Titanium. All wetted materials shall be safe for permanent use in marine environments.

F. Controller: Shall be provided with a programmable control system. Program options shall include for wave and random modes. The pump and/or controller shall include safety functions for dry running, high temperature, and overload protection.

G. Provide Manufacturer's grounding lug for connection from generator unit housing to building grounding for personal protection and with regard to dissipation of emitted electromagnetic interference (EMC).

H. Manufactures:

1. Base Manufacturer: *Abyzz America, LLC.* Star, ID www.abyzzamerica.com
   Supplied by: *CoralVue* Slidell, LA (985) 781-1220 www.CoralVue.com.
2. Alternate Manufacturer: "Hydrowizard" by *KAG* email to fish@belowwater.com.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with the Manufacturer's instructions at locations indicated on the Drawings.

B. Location: Position under the water surface at a location as directed by the Aquarium operator at the time of construction.

C. Controller: Install controller with wall-mount for dry, safe, and accessible location. Do not mount the controller directly over water.

D. Mounting: Only Type 316/316L stainless steel fasteners shall be used.

E. Contractor shall ensure electrical equipment is in conformance with a listed testing laboratory and bears certification labeling.

F. Contractor shall install secondary grounding for generator unit housing to building grounding with electrical.

END OF SECTION

SECTION 170110 - CHEMICAL METERING PUMPS

PART 1 - GENERAL

1.1 USAGE

A. The chemical metering pumps are used for pumping acid, base, chlorine, bromine, saltwater, or RO freshwater.

1.2 GENERAL REQUIREMENTS

A. General: The General Conditions apply to this Section as fully as if repeated herein. In addition to metering pumps, provide storage tanks and agitators as specified below and indicated on the drawings.

B. Operating Characteristics: Pump capacity, maximum operating pressure, electrical requirements, and other requirements as shown on the drawings.

C. Codes: Comply with all applicable safety codes, ASTM, and ANSI.

D. Electrical equipment shall be in conformance with all local, State of North Carolina, and Federal codes, statutes and ordinances where they apply, including required listing by testing authorities. Acceptable listing authorities include Underwriters Laboratory (UL), Canadian Standards Association (CSA), or other approved by the State of North Carolina.

1.3 SUBMITTALS

A. Submit complete motor and pump data together with dimensional drawings, indicate model numbers, pumping rate and pressure rating, listing of all types of materials and specific list of optional equipment provided. For the motor: motor type, horsepower, voltage rating, number of phases, and name of motor manufacturer. Submit installation instructions, for review, prior to approval. Submit warranty.

B. Submit proof that installed materials will bear approved testing agency listing mark or classification markings.

1.4 WARRANTY

A. Warranty: Guaranteed against defective parts for a minimum of 2-years from the date of startup in the complete system, or 2-years after Owner acceptance of the units from the installing Contractor, whichever is less.

1.5 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in section 170010.

1.6 COORDINATION

A. Coordinate with separate on/off power relay.

PART 2 - PRODUCTS

2.1 STENNER PERISTALTIC-TYPE CHEMICAL METERING PUMPS

A. General: Peristaltic-type with variable output. All units shall be of the same manufacturer. Provide in capacities and for specific uses as given on the Pump Schedule of the Drawings.

B. Pump Head: Clear plastic, peristaltic roller housing, removable from the motor housing without the use of tools. Output volume adjustable, while pumps are in operation, from 5% to 100% by means of a rotating bezel ring.

C. Drive: Pump drive incorporating a fan cooled motor, on/off toggle switch, with standard three prong receptacle plug.

D. Mounting: Provide with corrosion resistant mounting bracket.

E. Pump Tubing: Tygon tubing "beige" color, or Santoprene, resistant to ozone and UV light; or approved equal. Tubing shall meet USP Class VI, FDA, and NSF criteria. Sized as required for proper pump operation. Manufactured by: Norton “Phar Med” supplied by AIN Plastics Inc. Santa Fe Springs, CA (310) 946-2351; or approved substitute.

F. Required Options and Spares:

1. Clay lead tube weight (to submerge the foot valve).
2. A foot valve with integral strainer.
3. Spare pumping tube assembly.
4. 20 foot of 3/8 inch lead tubing.
5. Connection fittings, nuts and ferrules.

G. Manufacturer: *G.H. Stenner and Co.* Jacksonville, FL (800) 683-BEST; or approved substitute.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with the Manufacturer's instructions at locations indicated on the drawings.

B. Mounting: Only Type 316 stainless steel hardware shall be used.

C. Connections: Provide all necessary tubes and fittings to install as indicated on the drawings.

D. Splash Shield: Provide hinged acrylic splash shield at pump shelf to prevent facial exposure to accidental spray from loose or incorrectly attached tubing. The hinges and all hardware shall be nonmetallic or Type 316 stainless steel.

1 END OF SECTION

SECTION 170120 - HORIZONTAL FRP PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Pump capacity, horsepower, TDH (Total Dynamic Head), speed, minimum efficiency, suction and discharge diameters, type, and other requirements shall be as shown on the drawings and shall comply with the requirements as specified herein for each type of service. The General Conditions shall apply to this Section as fully as if repeated herein.

B. Pump performance shall be optimized with provision of variable speed drives (VFDs) where designated.

C. The specified *Fybroc* pumps are built to ANSI dimensional standards.

1.2 CODES

A. Comply with all applicable safety codes, ASTM, and ASME/ANSI.

1.3 COORDINATION

A. Housekeeping Pads: Concrete material for base of frame mounted pumps is to be provided in accordance with the Structural Drawings; coordinate concrete work with baseplate sizes.

B. Coordinate Power Supply with Electrical: The Contractor is responsible to fully coordinate pump motor sizing with the electrical power supply. Coordinate power wiring from motor starter, to junction box on pump motor, with Electrical Division of the Project Manual and Electrical Code requirements. See Electrical drawings for power supply to the motor starters.

C. Coordinate VFDs with Electrical: Variable frequency drives (VFDs) and motor starters are called out in the Electrical documents. The Mechanical Contractor is responsible to fully coordinate pump motor sizing with the electrical power supply. Installation of the specified braided grounding cable required a ground termination, installed at the pump by, as approved by the Electrical requirements.

D. Seal Flush Piping Plan: Coordinate the seal flush piping “Plan” with manufacture for each specific pump installation.

E. Where pumps are equipped with local controls provided by the pump manufacturer, control wiring shall be fully coordinated with the Electrical Contractor.

F. The following pumps shall be supplied with abrasion-resistant VR-1A resin and Plan 31 seal flush piping:

1. REC-PFIL01-001 & -002.
2. REC-PFRAC01-001.
3. REC-PTRN01-001 & -002.
4. SMU-PMIX01-001.

G. Temporary Startup Strainers: For *Fybroc* pumps not installed with permanent basket strainers in the pump suction piping, install temporary startup strainers prior to running any flow of water thorough the pumps.

1.4 SUBMITTALS

A. Submit shop drawings and product data in accordance with Division 1. Submittals shall include a complete pump description plus material list including casings, impellers, covers, seals, shaft, hardware, bearing frame, motor mounts, guards, baseplate, exterior coatings, and the following items:

1. Certified dimensional drawings of each item of equipment and auxiliary apparatus to be furnished, including equipment weights and location and size of anchor bolts.
2. Literature and drawings describing the equipment, including parts list and materials of construction, in sufficient detail to indicate full conformance with the detail specifications.
3. Motor performance data and wiring diagrams.
4. Cut sheets on accessory items.
5. Manufacturer's certified rating curves, to satisfy the specified design conditions, showing pump characteristics of discharge, head, brake horsepower, efficiency and guaranteed net positive suction head required (NPSHR).
6. Where applicable, variable speed curves shall be provided showing at least three speeds plotted equally from maximum rpm to minimum rpm. Minimum rpm shall be no less than that required to obtain minimum flow. Curves shall show the full recommended range of performance and include shut off head. This information shall be prepared specifically for the pump proposed. The substitution with catalog sheets showing a family of curves will not be acceptable.

B. Installation Instructions and Operating and Maintenance Manuals shall include recommended protection and maintenance required for storage prior to putting pumps in service, and may be submitted anytime before shipment of the pumps.

C. Shop drawings of safety cages required around all rotating elements.

D. Submit technical information on special grounding of motors for VFD pumps.

E. Submit information on temporary startup strainers. Required in pump suction piping where design does not include permanent strainer baskets in the pump suction piping.

F. Submit statement that the Contractor will retain services of the manufacturer’s factory representative for checking alignment and initial operation. Or provide a statement that the Contractor will be responsible for alignment of frame-mounted pumps and motors and cover the all costs related to damage of the mechanical seals if mis-alignment is suspected.

G. Submit warranty covering or exceeding requirements given below.

1.5 WARRANTY

A. Pump equipment Manufacturer shall warrant and guarantee all equipment furnished to be free from defect in materials for a minimum of 1-year from the date of startup of the complete system, or 1-year after Owner acceptance of the units from the installing Contractor, whichever date occurs first. Manufacturer’s warranty shall not relieve the Contractor from furnishing a complete system warranty as specified in the General Conditions. The motor manufacturer’s standard warranty shall not be reduced because of use with a variable speed drive service.

1.6 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Sectional 170010.

1.7 CURVE FITTING FOR VARIABLE FREQUENCY DRIVE (VFD) APPLICATIONS

A. Trim & Speed Selection: Pump supplier shall optimize the pump efficiency by varying the speed and impeller trim given the following constraints:

1. Filter Pumps:

   a. Must produce 100% of scheduled GPM and 100% scheduled TDH between 85% to 100% of scheduled speed.
   b. Manufacturer shall optimize impeller trim for maximum efficiency at 100% scheduled GPM and 80% scheduled TDH.
   c. Final impeller trim shall be coordinated with the submittal review by the Engineer and shall be the maximum possible diameter without requiring an increase to the motor horsepower.

2. Other Pumps: Typically select most efficient impeller trim for pump operating at scheduled speed, flow, and TDH. Where increased efficiency can be gained by operating at a lower than scheduled speed, manufacturer shall provide the higher efficiency pump with speed reduction by the VFD; where cost is a consideration, the higher efficiency pump may be listed as an alternate to the basic size scheduled pump.

1.8 FACTORY TESTING

A. Factory performance testing — required for all frame-mounted centrifugal pumps: a non-witnessed factory test, per Hydraulic Institute Standards; Acceptance Level A, per ANSI/HI 1.6-2000 or latest revision; shall be performed on one pump of each size and trim. Tests may be those previously performed on identical pumps, or otherwise, shall be performed on the actual pumps supplied for this project.

1.9 MANUFACTURER

A. *Fybroc*, *CECO Environmental* (1500 Series, frame-mounted/long-coupled); (1530 Series, close-coupled) Telford, PA (215) 723-8155 www.cecoenviro.com .

PART 2 - PRODUCTS

2.1 FRP END-SUCTION CENTRIFUGAL PUMPS

A. Type: In accordance with latest revision of the American National Standard ASME/ANSI B73.5, "Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process." The following types of pumps shall be as per the Pump Schedule on the Drawings:

1. "Frame-Mounted" *Fybroc* Series1500 Process Pumps.
2. "Close-Coupled" *Fybroc* Series 1530 Process Pumps.
3. Recessed Impeller" *Fybroc* Series 3000.

B. Impellers & Casings:

1. General: Impellers shall be semi-open impeller type and shaft sleeve shall be integral one-piece design without gaskets or O-rings. Casings shall be continuous-strand FRP thermoset construction for maximum strength and corrosion resistance. Casing volutes shall have foot mounts and be of one-piece construction with integral flat face flanges dimensioned according to ANSI/ASME B16.5 Class 150).
2. *Fybroc* Series 1500 Frame-Mounted Process Pumps: Frame-mounted pumps shall employ drop-out or spacer-type coupling for ease of servicing drive shafts and seals. Shaft thrust adjustment shall be by means of external jack screws or micrometer-type adjuster.
3. *Fybroc* Series 1530 Close-Coupled Process Pumps: Shipped from the pump manufacture with a ridged power frame connecting the motor to the pump casing.
4. *Fybroc* Series 3000 Recessed Impeller Pumps: Designed with a recessed impeller, with internal clearances, to provide smooth flow-through of water with solids content and heavy-duty applications. Suitable for pumping seawater of 3.3 percent salinity, sand and grit suspended in the water, and capable of passing spheres up to 1-7/8 inches in diameter. The impeller shall be radial-vained, non-clog, and located outside of the flow path. Capable of operating under continuous vacuum conditions. Available with “frame-mounted” pump motor combinations. The casing shall be a back-pullout design with external adjustment for the shaft thrust.

C. Power Frames: Cast iron or ductile iron. The exterior surfaces shall have a highly corrosion resistant treatment and coating system conforming to the coating requirements specified below. The metal power frame shall have an electrical bonding wire connected to the main grounded components or have a separate identified ground wire terminal.

1. Frame-Mounted Pump/Motor Combinations:

    a. Bearing housing shall have inboard single row radial bearing and outboard double row axial thrust bearings.
    b. Bearings shall be oil lubricated and built with oil reservoir and sight glass for ease of filling, fill port to prevent overfilling, and INPRO Type VBX labyrinth seals, or approved equal.
    c. Equip with standard Woods SC couplings, Dodge D-Flex couplings, or approved substitute.
    d. Provide nickel-plated bronze and Viton labyrinth type oil seals with all frame mounted end suction centrifugal pumps. *INPRO/SealTM Type VBX,* or approved equal.
    e. Safety Guards: Provide a corrosion resistant stainless steel or non-metallic guard covering all rotating elements, including shaft, coupling and mechanical seal and/or otherwise in compliance with OSHA Standard 29 CRF 1910.219

2. Close-Coupled Pump/Motor Combinations: Power frame built for ridged connection of the pump casing to the motor while allowing for installation of mechanical water seal at the back of the pump casing.

D. Suitability and Materials: The pump shall be suitable for pumping seawater of 3.3 percent salinity. Where materials of construction are not specified herein, the Manufacturer shall use first class, commercial grades best-suited for the particular use for which they are employed and shall conform to the following:

1. Pump casing: Fiberglass Reinforced Polymer (FRP)* with vinyl ester resin.
2. Pump impeller: Fiberglass Reinforced Polymer (FRP)* with vinyl ester resin.
3. Pump shaft: Type 316 or 2205 stainless steel.
4. Bearing Housing: Cast iron or ductile iron.

* Pumps designated for ""Recovery" and "Mixing" applications shall be supplied with abrasion-resistant materials such as *Fybroc* VR-1A or equal.

E. Baseplate and Mounts:

1. Base Mount for Grout Fill: Shall be of highly corrosion resistant FRP material, rigid construction, sloped drip pan under the pump with tapped drain connection, threaded inserts to accept all ASME/ANSI pumps and NEMA/IEC frame motors, drilled and tapped for pump and motor mounting bolts, and with grout holes. Pump and motor shall be factory mounted on the common baseplate.
2. All shims shall be of Type 316 Stainless Steel. All blocking shall be of specified materials; non fiber-reinforced plastic not allowed.

2.2 CORROSION-RESISTANT COATING REQUIREMENTS

A. All external exposed ferrous metal parts, except stainless steel, to be factory coated as follows:

1. Surface Preparation: Break all sharp edges by grinding or filing to prevent "pin-pointing" of coating. Prepare base metal with abrasive blast and/or solvent cleaning to remove any contaminants, grease, mill scale, oil, and oxidation products. Follow with treatment of the cleaned surfaces with zinc or iron phosphate to improve corrosion protection.
2. Corrosion Resistant Coating: Finish with a coating system consisting, recommended for corrosion resistance, of no less than two coats epoxy with a minimum total dry film thickness of 8-12 mils, or a polyester thermosetting powder coating (Spraylat PRPL 96005 or approved equal) with a minimum total dry film thickness of 5-8 mils.

B. Exterior Motor Coatings: All external metal parts, except stainless steel, shall be protected with the motor manufacturer's recommended coating system for maximum corrosion-resistance. No less than two coats epoxy are required with a minimum total dry film thickness of 8-12 mils.

2.3 MOTORS

A. Motor Types: All motors shall be totally enclosed and fan cooled (TEFC). Exposure duties shall be as follows:

1. Motors 1-hp and smaller shall be either Chemical Duty, Severe Duty, or coated to resist corrosion.
2. Motors 2-hp through 5-hp shall meet the NEMA Standard for Chemical Duty and Premium Efficiency.
3. Motors larger than 5-hp shall meet NEMA Standards for either Chemical Duty or Severe Duty and Premium Efficiency.
4. Motors powered by variable frequency drives shall meet the NEMA Standard for Inverter Duty, MG1, Part 31.

B. Motor Sizing: Fixed-speed motors shall not overload for pump flows between zero and 130 percent of the pump design point; however, certain motors have been scheduled on the Drawings for non-overload throughout the operational range of the pump curve, such as vacuum service pumps. Minimum size of motors for installation with Variable Frequency Drives shall be sized for full synchronous speed. Pump supplier shall verify scheduled horsepower meets above requirements and in no case shall the horsepower be less than indicated on the Drawings without specific approval from the Engineer.

C. Power: Electrical requirements including phase, frequency, and voltage are indicated on the Drawings. Motors shall have minimum 1.15 service factor. The pump manufacturer shall verify motor is sized for rated shaft horsepower at full load 60 Hz speed (full synchronous speed) regardless of selected operating speed, unless noted otherwise on the Drawings. Vendor shall confirm that motor current does not exceed allowable full load amperage at reduced frequency.

D. Insulation: Class F insulation minimum for Class B temperature rise.

E. VFD Duty: Where a Variable Frequency Drive (VFD) requirement is indicated on the Drawings, the motors shall be rated by the motor manufacturer for variable frequency duty and meet requirements of NEMA MG1-1993, Part 31.

F. Motor Efficiencies: For VFD applications, *Inverter Duty* motors shall be supplied as specified above. All single speed motors shall be either "High Efficiency" or "Premium Efficient" as specified below.

1. Motors 1-hp and smaller shall be "High Efficiency" motors or better (unless Inverter Duty is required).
2. Motors larger than 1-hp shall meet or exceed the "Premium Efficient" motors mandated by U.S. Department of Energy, Energy Policy Act (EPACT) of 1992 (except in the case where Inverter Duty motors are required); "Premium Efficient" motors shall have higher full-load efficiencies than "High Efficiency" motors as defined by IEEE Standard 112, Method B.

G. VFD Motor Grounding: All VFD pumps and Inverter duty motors shall be provided with shaft grounding rings to dissipate the buildup and discharge of electric currents within the motor and/or its bearings. Grounding rings shall be provided and installed by the motor or pump manufacturer. Manufactured by:

1. *Aegis,* Mechanic Falls, ME, (207) 998-5140 www.est-aegis.com;
2. *Shaft Grounding Systems* (SGS), Florence, Oregon (541) 997-4068 www.shaftgroundingsystems.com;
3. or approved substitute.

2.4 MECHANICAL SEALS

A. Pump seals shall be compatible with other pump materials with regard to corrosion resistance and wear. The pump supplier shall take full responsibility for proper installation and selection for application of all seals. Mechanicals seals shall be flushed via an internal pump cover flush, unless shown on the Drawings or otherwise specified. This shall allow the process fluid to recirculate internally and provide a flush of the mechanical seal faces, thereby eliminating the need for a separate fresh water flush.

B. Main seals:

1. Process type pumps larger than 5-horsepower shall be provided with single external mechanical type seals. Seal face materials shall be carbon versus chemical grade ceramic, or silicon carbide versus silicon carbide (where designated for abrasive applications), or as selected by the pump manufacturer for the specific application. Elastomers shall be EPDM or Viton rubber. Glands and sleeves shall be Type 316 SS or FRP. Metal parts shall be Type 316 SS and springs shall be of Type 316 SS or Hastelloy-C. John Crane single 8B2 seal.
2. Smaller pumps shall be provided with the Manufacturer's recommended mechanical seal suitable for saltwater, unless otherwise indicated on the drawings.

2.5 SEAL FLUSH PIPING PLAN

A. Seal Flush Piping Plan: Provide with fittings and tubing for the following arrangements as applicable for the specific installations:

1. Plan 11: Circulation from pump discharge to seal chamber for typical horizontal process applications.
2. Plan 31: Seal flush from pump discharge through a cyclone separator for water with heavy laden suspended solids or sand. Applicable for pumping dirty backwash “Recovery” water, water with settlement, vacuuming pumps, and “Mixing” pumps.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Pumps shall be installed in accordance with the Manufacturer's instructions.

B. General Requirements:

1. Housekeeping Pads: Unless shown otherwise on the drawings, provide a concrete housekeeping pad for all pumps.
2. Pump Discharge Connections: The drawings show suction and discharge sizes for the pumps. Increasers or reducers, as may be required at the pump outlet port, and shall be provided by the installing Contractor. All increasers on the discharge side of pumps shall be FRP gradual reducers by Conley Composites www.conleyfrp.com, or equal, and substitution with bushing fittings is not acceptable.
3. Where "reducing" type flex couplings are indicated at the pump suctions, "straight" type couplings shall not be substituted.
4. Piping Alignment: Inlet and outlet piping must be in alignment with pump nozzles prior to fastening and not re-aligned by bolting to pump.
5. Start-up Strainers: Install temporary cone strainers in the intake pipe, directly before each pump where a permanent basket strainer is installed upstream of the pump.

C. Additional Requirements for Frame-Mounted Pumps:

1. Pre-Alignment: Prior to grout fill rigidly securing the mounting base, adjust alignment of pump base so there is no stress between the pump and the piping.
2. Rotation: Verify motor rotation with motor coupling disconnected.
3. Pump/Motor Alignment: Proper field alignment is the responsibility of the Contractor. The Contractor shall retain and coordinate services of the manufacturer’s factory representative to check the pumps, assembly, installation, alignment and initial operation.
4. Certify Installation: Prior to operation of each pump, an authorized manufacturer’s representative shall certify the installation meets manufacturer’s instructions. An authorized representative shall be present at pump startup. After installation, the Contractor shall deliver to the Owner a certificate of proper pump installation authorized by the pump manufacturer.

D. Close-Coupled Pumps:

1. Where not mounted on a factory solid-filled baseplate, the base mounts shall be solid grout filed by the installing Contractor including provision of grout-stop at open end(s) if required.

2. Rotation: Verify motor rotation, starting with an electronic rotation checker, and cautiously initially bumping power to the pump.

E. Grout Fill FRP Bases: Before the pumps and motors are aligned and certified as properly installed, the cavity between the FRP baseplate and the housekeeping pad shall be filled with non-shrink grout. It may be necessary for the Contractor to drill "extra" grout holes in addition to those provided by the pump manufacturer. It is essential that non-metallic bases are completely and fully grouted without any air-gaps or voids below the top plate. Steel base frames do not require a grout fill

F. Grounding for VFD Driven Pumps:

1. Insure motor shafts are provided with grounding rings to prevent stray currents from traveling through bearings. Complete any grounding in accordance with the recommendations or the manufacture of the grounding rings.
2. Install a braided tin-plated copper ground wire from the power frame to an established ground termination. This cable is required in addition to any other grounding wiring.

G. Do not install valves directly on pump discharge flanges.

H. Where seal flush tubing is delivered separate of the pump, complete the tubing installation with the Seal Flush Plan Piping in accordance to the installed application and the manufacturer's recommendations. Contractor shall verify that "Recovery" pumps and "Mixing" pumps are installed with Plan 31 or better seal flush.

I. Startup pumps in accordance with manufacturer's recommendations. Pumps must be flooded or primed with water prior to starting. Open the inlet valve. Close, or partially close, the discharge valve; then open discharge valve slowly soon after starting the pump.

J. Technical Seminar: At completion of the installation, the contractor shall make arrangements for technical seminar by the pump factory representative to the owner' staff. The seminar shall include instruction on pumping operations, seal replacement, shaft alignment, lubrication, preventative maintenance, and other routine maintenance requirements.

END OF SECTION

SECTION 170129 - SMALL COMPOSITE PUMPS & CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Pumps are installed for all 120V, 1 phase DC pumps noted on the pump schedule, shall be horizontal centrifugal type, and may be installed submerged in water or mounted in air environment The submersible pumps are typically used in process treatment reservoirs with less than a 6-ft water depth.

B. Pump capacity, power, TDH (Total Dynamic Head), suction and discharge diameters, type, and other requirements shall be as scheduled on the Drawings and shall comply with the requirements as specified herein for each type of service. The General Conditions shall apply to this Section as fully as if repeated herein.

C. Provide one spare pump for unit size called out in equipment schedule.

1.2 PUMPS AND CONTROLLERS

A. Quantity of Controllers: Installed with one (1) pump with one (1) dedicated controller, 1:1.

B. Power wiring to the pump controllers shall be completed by the Contractor in the field per the electrical Design Documents. Cables from controllers to the pumps, shall be provided by the manufacture, and installed per the LSS Design Documents.

1.3 QUALITY ASSURANCE

A. Pumps and motors shall be preassembled at the factory to ensure proper fit.

B. Testing Laboratory Requirements: Acceptable qualified testing laboratories shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) for Labels on Electrical & Mechanical Equipment. Acceptable listing agencies include Canadian Standards Association (CSA), Intertek Testing Services ITS-ETL, and Underwriters Laboratory (UL). The supplier/ manufacturer shall be fully responsible for compliance with this requirement. If field approval is necessary to meet listing requirements, it shall be completed without delay to the project and at no additional cost to the Owner.

1.4 COORDINATION

A. Mounting of Controllers: Coordinate mounting of local controllers on stanchion, or appropriate mount, and coordinate with current breaker and power cable provided with the Electrical Design Documents. Location of the controllers shall allow for ease of operator access, avoid any splashing of water from associated reservoir tanks, and minimize length of power cables from the controller to the tanks.

B. Connection Cable Length: Coordinate length required for the cable from the controller or drivers, to the submersible pumps, with factory cable options and each installation requirement for the length of cable.

C. Cable Conduits: Where conduits are provided by the Contractor for wiring, the diameter may have to be oversized to accommodate the pump manufacturer's standard materials.

1.5 SUBMITTALS

A. Submit complete motor and pump data. Characteristic curves showing flow, TDH, efficiency, and power. Complete pump description plus material list including casings, impellers, seals, shaft, bearing frame, and fasteners. Submit guaranteed maximum submergence depth.

B. Submit physical and operational data for controllers.

C. Submit warranty.

1.6 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010.

1.7 WARRANTY

A. The manufacture shall warranty the pumps and controllers to be free of defects in material and workmanship for 2-years after startup in the water treatment system, or 2-years after Owner acceptance of the units from the installing Contractor, whichever is less.

PART 2 - PRODUCTS

2.1 10 GPM AND GREATER SMALL COMPOSITE SUBMERSIBLE PUMPS

A. General: The submerged pumps shall be suitable for pumping saltwater. Where materials of construction are not specified herein, the manufacturer shall use first class commercial grades best suited for the particular use for which they are employed. The centrifugal type pumps shall have direct suction to a high efficiency impeller. Shall be built for installation in no less than 2-meter water depth.

B. Balance: All rotating parts shall be accurately machined and trimmed for optimum rotational balance.

C. Materials: All wetted components of plastic or Titanium. All wetted materials shall be safe for permanent use in marine environments.

D. Inlet/Outlet: Order and deliver with optional "Imperial" size port adapters.

E. Motor: Integrated motor designed to run submerged in saltwater and DC powered by the provided controller.

F. Controller/Drive: Factory packaged with a programmable driver with a soft start. Program options shall include for wave bursts and random modes. The pump and/or controller shall include safety functions for dry running, high temperature, and overload protection.

G. Connection Cable: The pump shall be delivered with connecting cable and permanently sealed against water intrusion at the motor end.

H. Controller / Drivers

1. General: Compact, high performance, high functionality, high quality, current vector motor drive. The programmable unit shall have the following features:

    a. Variable speed range from 0 to 130% of synchronous motor speed.
    b. Dry run protection.
    c. Soft start.
    d. Temperature protection.
    e. Over-current protection.
    f. Low noise operation.

2. Design Features: Shall include microprocessor logic, push-button operation adjustments, LED status display. IP65-rated splash-proof controller.
3. Service Conditions: Ambient service temperature: 2 deg C to 40 deg C (33 deg F to 105 deg F).
4. Frequency Performance:

    a. Input frequency: +/-5%; 50/60 Hz
    b. Output frequency: 0 to 78 Hz (or greater)
    c. Frequency resolution: 0.01 Hz with digital reference or 0.06 / 60 Hz with analog reference.
    d. Frequency accuracy: 0.01% with digital command or 0.5% with analog command function.

5. Display: The display shall have an overview of pump operating conditions, including the following:

    a. Adjusted power setting in percent.
    b. Driver temperature.
    c. Operating mode.
    d. LED status lamp indicating the product is working properly.
    e. Other factory status options.

6. Shall include the following protective features: Current limit, stall prevention, motor and drive overload, over and under voltage prevention, instantaneous over current, and ground fault protection.

I. Manufacturer of Packaged Pump and Controller

1. Base Manufacturer*: Abyzz America, LLC.* Star, ID www.abyzzamerica.com
2. Alternate Manufacturers: Alternate potential manufacturers shall not compromise the above specified requirements and may require the Contactor to make adjustments in pipe routing, equipment layout, and power supply from what is shown on the Drawings.

2.2 10 GPM AND LESS SMALL COMPOSITE SUBMERSIBLE PUMPS

A. General: The versatile submersible and non-submersible application pumps shall be suitable for pumping saltwater.

B. Materials: All wetted components of plastic or Titanium. All wetted materials shall be safe for permanent use in marine environments.

C. Inlet/Outlet: Included with “QuickCouple” connectors.

D. Motor: Integrated motor designed to run submerged in saltwater and DC powered by the provided controller.

E. Controller/Drive: Factory packaged with a programmable driver with a soft start. Program options shall include for wave bursts and random modes. The pump and/or controller shall include safety functions for dry running, high temperature, and overload protection.

F. Connection Cable: The pump shall be delivered with connecting cable and permanently sealed against water intrusion at the motor end.

G. Manufacturer of Packaged Pump and Controller/Driver

H. Base Manufactuer:

1. Vectra Return Pump *by Ecotech Marine* https://ecotechmarine.com/vectra. Supplied by: CoralVue Slidell, LA (985) 781-1220 www.CoralVue.com.
2. Alternate Manufacturers: Alternate potential manufacturers shall not compromise the above specified requirements and may require the Contactor to make adjustments in pipe routing, equipment layout, and power supply from what is shown on the Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Pumps shall be installed in accordance with the Manufacturer's instructions. The composite plastic submersible pumps shall not be installed in water depths exceeding 6-foot.

B. The installation of the controllers/drivers shall be completed as compact as possible while maintaining required safety clearances. The location shall be free of, or otherwise protected from, water splashing and moisture. Ensure sufficient air flow for cooling of drivers.

C. Rotation: Verify motor rotation prior to final installation.

D. Demonstrate proper operation of pumps and controllers to the Owner’s staff.

E. Deliver spare pumps to Owner at end of construction (refer to equipment schedule)

END OF SECTION

SECTION 170130 - GENESYS & ADVANCED MDM PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. This specification is limited to only “Genesys” and “Advanced” models as manufactured by *MDM Pumps*.

B. Pump capacity, horsepower, TDH (Total Dynamic Head), speed, minimum efficiency, suction and discharge diameters, type, and other requirements shall be as shown on the drawings and shall comply with the requirements as specified herein for each type of service. The General Conditions shall apply to this Section as fully as if repeated herein.

1.2 COORDINATION

A. Housekeeping Pads: Provide concrete pad as required for level mounting condition.

B. Anchoring for “Genesys” Pumps: Install Type 316 SS female inserts in concrete base pad matching alignment of pump anchor bolts. See pump detail on drawings.

C. Coordinate with Electrical: The Contractor is responsible to fully coordinate the electrical power supply with the pump motor sizing. Coordinate power wiring from motor starter, to junction box on pump motor, with Electrical Division of the Project Manual and Electrical Code requirements. See Electrical drawings for power supply to the motor starters.

D. VFDs: Coordinate pumps with Variable Frequency Drives (VFDs) with the Electrical Design Documents.

1. VFDs and starter switches shall be provided per the Electrical Design Documents at pump locations where VFDs are called for on the LSS Pump Schedule.
2. Provide each VFD pump installation with an Inductive Absorber, and/or shaft Grounding Ring as specified below.

E. Coordinate Seal Flush Piping Plan:

1. Plan 1: Applicable for pump Tag No.: FMU-PHEX01-001.
2. Plan 13: Circulation from seal chamber to pump suction for typical saltwater process applications.
3. Plan 31: Applicable for Tag No.: REC-PFIL01-001 & -002.

1.3 SUBMITTALS

A. Submit complete motor and pump data. Characteristic curves showing flow, TDH, efficiency, horsepower, and NPSH required. Complete pump description plus material list including casings, impellers, seals, shaft, bearing frame, motor mounts, guards, base plate, and exteriors.

1. Dimensional drawings of each item of equipment and auxiliary apparatus to be furnished, including equipment weights and location and size of anchor bolts.
2. Literature and drawings describing the equipment, including parts list and materials of construction, in sufficient detail to indicate full conformance with the detail specifications.
3. Motor performance data and wiring diagrams.
4. Manufacturer's certified rating curves, to satisfy the specified design conditions, showing pump characteristics of discharge, head, brake horsepower, efficiency and net positive suction head required (NPSHr).
5. Where applicable, submit information on the seal-flush plan.
6. For “Genesys” pumps submit information on factory-supplied spacer matching the motor mounts with the pump casing mounts.

1.4 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010.

1.5 WARRANTY

A. The pump manufacture shall warranty products to be free of defects in material and workmanship, and perform as specified, for 1-year after startup in the water treatment system, or 1-year after Owner acceptance of the units from the installing Contractor, whichever is less. The manufacture shall replace or repair products found defective within the 1-year warranty period.

PART 2 - PRODUCTS

2.1 “GENESYS” MODEL NON-METALLIC CLOSE COUPLED PUMPS

A. Type: Industrial end suction centrifugal pumps with flange casing connections and close coupled motor. Shall be a true back-pullout design allowing pump casing to remain bolted to piping while performing maintenance on seal and impeller.

B. Materials: The pump shall be suitable for pumping seawater of 3.3 percent salinity. All wetted parts shall be of non-metallic, stainless steel, corrosion resistant material.

1. Pump Casing: Compression molded thermoset cross-linked vinyl ester resin.
2. Impeller: Noryl plastic.
3. Seal: Non-metallic seal, selected by manufacturer, for compatibility with saltwater. Impenatra® non-metallic seal by *MDM* or equal. With EPDM elastomers.
4. Impeller Insert: If required, Type 316 SS threaded impeller insert suitable for saltwater duty.

C. Motor: Equipped with a TEFC motor, voltage and current phases as scheduled on the Drawings.

1. 3- phase motors, or 0.5 hp and larger, shall have Class F insulation; smaller motors may have manufacturer’s selected insulation Class protection against overheating.
2. Where used with variable frequency drives (VFDs), the motor shall for sustained operation while running on the active VFD and capable of a minimum 2:1 turn-down ratio.
3. Factory equipped with motor support spacer for matching base of pump casing mounts.

D. Seal Flush Piping Plan: Provide with fittings and tubing for the following arrangements as applicable for the specific installations:

1. Plan 1: No seal flush piping for intermittent duty freshwater applications.
2. Plan 13: Circulation from seal chamber to pump suction for typical saltwater process applications.
3. Plan 31: Seal flush from pump discharge through a cyclone separator for water with heavy laden suspended solids or sand. Installed for pumping dirty backwash water, water with settlement, or a vacuuming pumps.
4. Plan 32: Seal flush from an external clean source where pumps operate with a negative pressure at the suction such as a primed operation.

E. Model Manufacturer: *MDM "Genesys" pump,* Colorado Springs, CO (800) 447-8342 www.mdminc.com.

2.2 "ADVANCED" MODEL NON-METALLIC CLOSE COUPLED PUMPS

A. Type: Industrial end suction centrifugal pumps with threaded-type casing connections and close coupled motor. The pump and motor assembly shall be designed to allow access to impeller, seals and motor, with the pump volute remaining connected to the piping. Semi-open type impeller.

B. Materials: The pump shall be suitable for pumping seawater of 3.3 percent salinity. All wetted parts shall be of non-metallic, stainless steel, corrosion resistant material.

1. Casing & Impeller: Molded glass reinforced Noryl plastic where available, otherwise Polypropylene.
2. Seal: Non-metallic seal, selected by manufacturer, for compatibility with saltwater. Impenatra® non-metallic seal by *MDM* or equal.
3. Impeller Insert: If required, Type 316 SS threaded impeller insert suitable for saltwater duty.

C. Motor: Equipped with a TEFC motor, voltage and current phases as scheduled on the Drawings. Where used with variable frequency drives (VFDs), the motor shall for sustained operation while running on the active VFD and capable of a minimum 2:1 turn-down ratio.

D. Model Manufacturer: *MDM "Advance" pump,* Colorado Springs, CO (800) 447-8342 www.mdminc.com.

2.3 INDUCTIVE ABSORBERS AND/OR GROUNDING RINGS.

A. VFD Motor Grounding or Induction Absorbers: All Inverter duty motors shall be provided with shaft grounding rings, or antistatic ring, and/or induction absorbers to help dissipate the buildup and discharge of electric currents within the motor and/or its bearings.

1. Shaft Grounding Rings: Shall be provided and installed by the motor or pump manufacturer. *Shaft Grounding Systems* (SGS), Florence, Oregon (541) 997-4068 www.shaftgroundingsystems.com; or *Aegis, Mechanic Falls, ME, (207) 998-5140 www.est-aegis.com;* or approved substitute.
2. Inductive Absorbers: These are to be installed on the power supply cables. "CoolBLUE" inductive absorbers by *MH&W International Corp* (201) 252-8125 www.coolblue-mhw.com; or approved substitute. Applies to pumps 0.5 hp and larger.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Pumps shall be installed in accordance with the Manufacturer's instructions.

B. For pumps 0.5 hp and larger, running on VFDs, install inductive absorbers on power cables or install shaft grounding rings. Installed inductive absorbers close to the VFD, on power cables, leading to the pump motors.

C. For pumps running on VFDs, install a braided tin-plated copper ground wire from the power frame to an established ground termination. This cable is required in addition to any other grounding wiring.

D. Inlet and outlet piping must be in alignment with pump nozzles prior to fastening and not re-aligned when fastening to pump.

E. Rotation: Verify motor rotation with motor coupling disconnected or verify motor rotation using a rotation tester for AC pump motors.

F. Prime pump, or flood with water, before running. Demonstrate proper operation of constant speed pumps and pumps with local VFDs.

3.2 “GENESYS” PUMP INSTALLATION

A. Pumps shall be installed in accordance with the Manufacturer's instructions and above “General” notes.

B. Where seal flush tubing is delivered separate of the pump, complete the tubing installation with the Seal Flush Plan Piping in accordance to the installed application and the manufacturer’s recommendations.

C. Verify a factory-supplied spacer is included for matching the motor mounts with the pump casing mounts.

D. Pump and motor shall be anchored to allow for removal of motor while leaving the pump casing anchored in place. Anchoring shall be done using threaded female inserts installed in the concrete base with Type 316 SS cap screws anchoring pump/motor flanges to the inserts. See pump installation detailing on Drawings.

3.3 “ADVANCED” PUMP INSTALLATION

A. Pumps shall be installed in accordance with the Manufacturer's instructions and above “General” notes.

B. Pump and motor shall be anchored to allow for removal of motor while leaving the pump casing anchored in place. Mount pump and motor on a thick HDPE baseplate. Mount the HDPE baseplate on Type 316 SS all-thread stanchions with a 2.5-inch space below the HDPE baseplate for access to pump and motor mount fasteners. See pump installation detailing on the Drawings.

1 END OF SECTION

SECTION 170138 - MAGNETIC DRIVE PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Pump capacity, horsepower, TDH (Total Dynamic Head), speed, minimum efficiency, suction and discharge diameters, type, and other requirements shall be as shown on the drawings and shall comply with the requirements as specified herein for each type of service. The General Conditions shall apply to this Section as fully as if repeated herein.

1.2 COORDINATION

A. Housekeeping Pads: Provide concrete pad as required for level mounting condition.

B. Coordinate with Electrical: Coordinate power wiring from motor starter, to junction box on pump motor, with Electrical Division of the Project Manual and Electrical Code requirements.

1.3 SUBMITTALS

A. Submit complete motor and pump data. Characteristic curves showing flow, TDH, efficiency, horsepower, and NPSH required. Complete pump description plus material list including casings, impellers, motor mounts, and exterior coatings.

B. Submit warranty covering or exceeding requirements given below.

1.4 WARRANTY

A. Pump equipment Manufacturer shall warrant and guarantee all equipment furnished to be free from defects in materials for a minimum of 1-year from the date of startup of the complete system, or 1-year after Owner acceptance of the units from the installing Contractor, whichever date occurs first. Manufacturer’s warranty shall not relieve the Contractor from furnishing a complete system warranty as specified in the General Conditions.

1.5 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010.

PART 2 - PRODUCTS

2.1 MAGNETIC DRIVE PUMPS

A. Suitability: Suitable for pumping clear saltwater of 3.3 percent salinity.

B. Materials: All wetted parts shall be of polypropylene, polyvinylidene fluoride resin, or suitable glass reinforced plastic. Exterior hardware shall be Type 316 Stainless Steel.

C. Type: End-suction, close-coupled, seal-less magnetic drive pump. Mounted via motor support bracket.

D. Motor shall be high energy efficient, TEFC, three-phase, 60 Hertz, 208 volts. Regardless of the motor horsepower given on the pump schedule, pump supplier shall verify specified horsepower meets the scheduled requirements.

E. Manufacturer:

1. *Iwaki America*, Holliston, MA (508) 429-1440 www.iwakiamerica.com;
2. Sethco Division (*Metpro Corporation*), Hauppauge, NY (516) 435-0530;
3. *March Manufacturing Inc*., Glenview, IL (708) 729-5300;
4. *Hayward Flow Control* – RX model GFPPL magnetic-drive pump Clemmons, NC (888) 429-4635;
5. or approved substitutes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Pumps shall be installed in accordance with the Manufacturer's instructions.

B. Inlet and outlet piping must be in alignment with pump nozzles prior to fastening and not re-aligned by bolting to pump.

C. Check motor rotation using a rotation tester for AC pump motors prior to “bump” testing for checking rotation.

D. Prime pump, or flood with water, before running.

END OF SECTION

SECTION 170140 - ELECTRIC VALVE ACTUATORS

PART 1 - GENERAL

1.1 SUMMARY

A. The location of electric valve actuators shall be as indicated on the Process and Instrumentation Diagrams and/or scale drawings. Sizing shall match requirement for valves and process conditions. The General Conditions apply to this Section as fully as if repeated herein.

B. The installing contractor shall make arrangements with the factory supplier of the actuators for final adjustment of limit switches and setting of all other operational parameters.

C. Motor actuators shall bear Underwriters Laboratories (U.L.) recognition, CSA or FM label.

1.2 COORDINATION

A. Before ordering, the Contractor shall verify the mating of actuators to valves. Whenever possible, it is recommended the valves and actuators are supplied to the Contractor as a single unit.

B. Coordinate for installation of higher VAC 3-phase power where electric actuators are installed for larger valves. For instance, valve 200 for the Sand Tiger Shark exhibit.

C. See specification Section 170142 for butterfly type valves.

D. See specification Section 170144 for ball type valves.

E. Electrical Contractor shall provide all conduit; provide, pull and terminate all wiring from electric valve actuators to controls cabinets. Termination shall consist of installing hard wiring for completion of circuits at termination points.

F. Coordinate with Automated Controls System (ACS) as required.

G. Contractor shall determine where oversized electric valve actuators may place excessive forces on valve/piping and provide separate support of such actuators as required. This situation is not uncommon for small actuated valves.

1.3 QUALITY CONTROL

A. Testing Laboratory Requirements: Acceptable qualified testing laboratories shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) for Labels on Electrical & Mechanical Equipment. Acceptable listing agencies include Canadian Standards Association (CSA), Intertek Testing Services ITS-ETL, and Underwriters Laboratory (UL). The manufacturer/supplier shall be fully responsible for compliance with this requirement. If field approval is necessary to meet listing requirements, it shall be completed without delay to the project and at no additional cost to the Owner.

1.4 SUBMITTAL

A. Submit complete information describing all dimensions and materials.

B. Submit list of required stem torque for opening and seating of selected valves and output torque of corresponding actuator. This will require coordination with the valve selection.

C. Submit details of factory and custom designed actuator extensions, mounts, extension supports and bushings where required.

D. Submit proof that installed materials will bear approved testing agency listing mark or classification markings.

1.5 WARRANTY

A. The manufacture shall warranty the entire actuator to be free of defects in material and workmanship for 2-years after startup in the water treatment system, or 2-years after Owner acceptance of the units from the installing Contractor, whichever is less. The manufacture shall replace any components found defective within the 2-year warranty period.

1.6 MAINTENANCE AND OPERATIONAL DATA AND TECHICAL SEMINAR

A. Include pertinent information in the project bound Operation & Maintenance Data Manual per requirements in Section 170100.

B. After installation and at the operational startup of the facility, the manufacturer's representative shall conduct an on-site training seminar for the owner's operational staff including instruction on basic operations and routine maintenance requirements.

PART 2 - PRODUCTS

2.1 MOTOR ACTUATORS FOR BUTTERFLY VALVES

A. Quarter-turn gear type electric motor operated actuator provided with the following:

1. Housing: Actuator housing and primary carriers of high-grade Aluminum, carbon steel, ductile iron, or composite non-metallic. Housing to be NEMA 4 enclosure rating with O-Ring seals. Housing shall have provisions for a visual position indicator.
2. Torque Rating: Torque rating shall be minimum of 25% in excess of calculated torque for the design or installed condition.
3. Coating: If ferrous metal, provide special "corrosion resistant" zinc primer with over-coating. For outdoor installation provide acrylic or polyester coating with UV inhibitors top-coat (epoxy not recommended for outdoor exposure).
4. Mounts and Couplings: Where mounting blocks are required, they shall be Type 316 stainless steel. Valve shaft coupling of carbon steel, bronze or Type 316 Stainless Steel.
5. Drivetrain: Annulus gear of epicyclic type actuators shall be of hardened steel or bronze alloy. Output drive, input gear, worm gear, compound gear shall be of steel (aluminum or plastic gears are not acceptable). Where applicable, drive shaft journal shall be of high-density polyethylene material other appropriate non-metallic product. The drivetrain shall be permanently lubricated with molybdenum grease.

6. Manual Operator: Manual override handwheel with "spinner" handle and valve position indicator. Manual Operator shall be clutch free design requiring no lever engagement for valve positioning via handwheel operation. Handwheel shall not rotate when actuator is in motor driven positioning state.
7. Over-torque: Equip with over-torque protection. Over-torque limit switches may be located in a compartment separate from the terminal compartment to allow adjustments without electrical hazard and, if so, an internal heater shall be provided in the separate compartment.
8. Heater: Provide internal heaters for reduction of condensation.
9. Sequencing: The following appurtenances shall be selected to meet requirements of the Automated Controls Supplier. "Typical" motor actuators shall be suitable for open and close control and capable of “Jogging or Pulse Modulation” for intermediate positioning via pulse powering
10. Motor Duty: Electric motor rated for continuous 15-minute duty and sized by the Manufacturer per conditions indicated on the drawings and based on an operating pressure of 50 psig. Motor actuator shall bear Underwriters Laboratories (U.L.) recognition, CSA or FM label. Motors shall have class F insulation rating or higher. Motors shall include internal thermal overload protection (self-resetting design) triggering at 275 deg F.
11. Brake: Actuator geartrain shall utilize a design to eliminate valve disc positioning via fluid force, or otherwise equipped with a positive brake.
12. Speed: Rotation time shall be 30-seconds or less for 90-degree of travel or include motor speed shall be potentiometer adjustable with a 6:1 turndown ratio.
13. Limit Switches: Two (2) sets of position limit switches, minimum, for opened and closed valve position. Limit switches for open/close valve position shall be independent of other internal contacts such as over-torque limit switches.
14. External Hardware: All exposed cap screws, washers and other hardware shall be of 300 Series stainless steel.
15. Electrical: Nominal motor voltage shall match project installation requirements. Actuator shall have a or, conduit connector with screw terminal for wiring connections.

B. Manufacturer and Models:

1. *EIM (Emerson Process Management)* Missouri City, TX (800) 679-1561 www.emersonprocess.com;
2. *Asahi/America* (“Series 10” or “Series 19”) Lawrence, MA 01843 (800) 343-3618 www.asahi-america.com;
3. *Hayward Flow Control*, HRS Series Clemmons, NC (888) 429-4635 www.haywardflowcontrol.com;
4. No substitutes.

2.2 MOTOR ACTUATORS FOR REVERSING TWO-WAY BALL VALVES

A. Coordinate with requirements of Automated Controls System meeting the following specifications:

1. Housing: Non-metallic composite construction or cast aluminum housing with thermally-bonded power coating. NEMA 4X enclosure rating and all covers to have O-Ring seals.
2. Motor Duty: Reversing-type electric motor rated for *minimum* of 25% duty at 10 second intervals.
3. Indicator: Shall have an external visual position indicator.
4. Limit Switches (required option): Open and closed limit switches with silver contact points.
5. Condensation Protection (required option with metal housings): Provide heater. May be thermostat activated of be constantly energized.
6. External Hardware: All exposed cap screws, washers and other shall be of 300 Series stainless steel material.

7. Actuator shall provide manual override capability via easily accessible externally mounted hex socket or spinner wheel.

B. Manufacturer and Models:

1. *Asahi/America*, Series 19 “SAV” SMART Actuator, Lawrence, MA 01843 (800) 343-3618 www.asahi-america.com;
2. *EIM Company, Inc*. www.eim-co.com;
3. *Hayward Flow Control*, HR2 Series Electric Actuators Clemmons, NC (888) 429-4635 www.haywardflowcontrol.com;
4. *Plast-O-Matic* Cedar Grove, NJ (973) 256-3000 www.plastomatic.com;
5. TRIAC Series 300/400 by *A-T Controls Group* Cincinnati, OH (513) 530-5175 www.a-tcontrols.com.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractor shall supply all materials and labor for the complete installation of all actuators, mounting to valves, and other specified equipment. Install actuators as required for a complete workable system in accordance with Manufacturer's recommendations.

B. Contractor shall ensure electrical equipment is in conformance with a approved testing laboratory listing and bears certification labeling.

C. Where the exact location of a actuator is not shown, it shall be installed in an accessible place and as directed by the Owner's Representative.

D. Shall be orientated to allow visual inspection of the valve position indicator from the service corridor path and installed to allow of routine servicing.

E. Install direct support of valve actuator where an “oversized” condition exists. Otherwise install direct support, or adjacent piping supports, to eliminate excessive deflection and carry the additional loading.

F. Install intermediate supports for valve operator extensions as recommended or required by valve or actuator manufacturer. Excessive deflection in the extension during normal operation, as determined by the Owner’s Representative, shall be corrected immediately by the Contractor at no additional cost to the Owner.

G. Contractor shall deliver services, as needed by the factory supplier of the actuators, for final adjustment of limit switches, setting of cam positions, completion of wiring terminations, and setting of all other operational parameters as required for fully functioning electric valve actuation.

END OF SECTION

SECTION 170142 - BUTTERFLY VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. The size and location of all valves shall be as indicated on the Process and Instrumentation Diagrams and/or scale drawings. The General Conditions apply to this Section as fully as if repeated herein.

B. All butterfly valves shall be installed with permanently fixed stainless steel or engraved plastic identification tag. All tags shall be of a neat and uniform design, with relief or engraved lettering. Tags shall clearly identify the valve number, as given on the Process and Instrumentation Diagrams. See specification Section 170010 for pipe and valve identification requirements.

C. All similar type butterfly valves shall be of the same manufacturer.

1.2 COORDINATION

A. Before ordering valves, the Contractor shall verify the mating of valves to selected flanges or other connections.

1. Where flanged bodied butterfly valves are installed, they shall be ordered to match adjoining flanges in all ways.
2. Contractor shall take all necessary measures to provide proper clearances, including verification of swing out requirements for butterfly valves, coordination of flange dimensions, slight modifications to standard flanges, or provision of additional spacers/shims.

B. Coordinate provision of electric actuators with specification Section 170140.

C. Coordinate ordering of butterfly valves with threaded lug inserts for the following installed locations. Otherwise, provide wafer style bodies without drilled lugs at typical in-line locations. Threaded lugs required at following locations:

1. Pump suction.
2. Filter effluents.
3. Heat exchanger influent and effluent.
4. Where required for isolation of auxiliary equipment.
5. Where specifically called for on the drawings.

D. Typically butterfly valves shall be installed with the shaft in a horizontal position, unless otherwise noted. Stems shall be in the horizontal position wherever there is a concern with debris flowing through the pipe. Valves with heavy electric actuators, and flowing clear filtered water, may be installed in the vertical position. Large diameter butterfly valves, at the discharge of deaeration towers, shall be installed with stem in the vertical position. See also requirements given below under Installation in Part 3.

1.3 SUBMITTAL

A. Submit complete information describing all dimensions and materials of valve composition.

B. Submit a schedule itemizing the location of each butterfly valve to be provided with lugs. Lug type butterfly valves shall be provided at the following locations, whereas either lug or non-lug wafer type butterfly valves may be provided at remaining locations:

1. Pump suctions.
2. Pump discharges where not entering a filter, heat exchanger or other isolatable unit process.
3. Filter discharge.
4. Heat exchanger discharge.
5. Ozone contactor discharge (ozone resistant valve).
6. UV sterilizer effluent and influent
7. Other “side stream” equipment where isolation of equipment is required for servicing equipment.

C. For all valves 12-inch diameter and greater, submit a table cross-referencing typical valve opening requirements with the opening diameter of the proposed flanges.

D. Submit details of factory and custom designed operator extensions, mounts, extension supports and bushings where required.

1.4 WARRANTY

A. The valve Manufacturer shall warrant and guarantee all products to be free from defect in materials for a minimum of 1-year from the date of startup of the complete system, or 1-year after Owner acceptance of the units from the installing Contractor, whichever date occurs first. Manufacturer’s warranty shall not relieve the Contractor from furnishing a complete system warranty as specified in the General Conditions.

1.5 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operation & Maintenance Data Manual per requirements in Section 170010.

PART 2 - PRODUCTS

2.1 GENERAL MATERIAL REQUIREMENTS

A. Coatings: All exposed metal parts, except stainless steel, to be factory coated. With consideration corrosion resistance, durability, and best use, coatings shall be provided as follows:

1. Nylon Coatings: Applicable for single piece valve bodies, valve disks, and actuator handwheels. Use standard factory applied product.
2. Dry Indoor Locations: Baked-on epoxy "powder" coating or high-solids liquid applied epoxy. Grind sharp corners, grit-blast, and otherwise prepare surfaces as necessary. If liquid epoxy: Apply no less than two coats, minimum dry film thickness of 12 mils. Or submit alternate coating for review.
3. Submerged, wet-dry, and outdoor locations: A high-performance zinc/acrylic coating system. Prime coat of inorganic zinc primer with not less than 80% total zinc in the dry film, *Carboline* "Carbo Zinc 11 RS", *Porter* Zinc Rich Epoxy Primer"*, International Protective Coatings* “Interzinc”; or approved substitute. Second and third coat with water-borne acrylic enamel compatible with the prime coat, *Carboline* "D3359", *Porter* DTM

Acrylic Gloss Enamel , *Dunn-Edwards* Permasheen; or equal; or for indoor locations the acrylic enamel may be substituted with epoxy or manufacturers selected topcoat.

B. Gaskets: Provide gaskets and sealants as recommended by the Manufacturer and as required. See specification Section 170010 for gasket materials. Butterfly valves with inner boot type seal do not require gaskets.

C. Fasteners: All valves shall be installed using only Type 316 stainless steel nuts, hex-head bolts, and washers per Section 170316. Substitution with “all-thread” is not an acceptable substitute.

2.2 ACTUATORS FOR BUTTERFLY VALVES

A. Lever Actuators: Quarter-Turn butterfly valves 4-inch in diameter and smaller provided with notch-position throttling handle. Handle, top locator-plate, spring, and hardware shall be non-metallic or 300 series stainless steel; hub of handle may be constructed of corrosion-resistant material other than stainless steel. Where indicated or required, provide valve stem extension as specified below under "Remote Operators."

B. Gear Actuators: Quarter-turn valves 6-inch in diameter and larger to be provided with enclosed submersible worm gear operator, with handwheel and position indicator. Packed with grease, O-ring seals, and rated for 3-psi submergence with IP67 weather resistance. Shall have the ISO bolt pattern conforming to 5211/I - 5211/II for valve mounting.

1. Components as follows: Non-metallic composite housing. Stainless steel fasteners. Worm Gear/Shaft of Beric zinc alloy.
2. Provide options where indicated on the drawings, including: remote chain operators, or locking devices.
3. Model & Manufacturer: Plasgear by ASAHI/AMERICA or equal.

C. Electric Actuators: Valves with electric actuators, shall be delivered to the Contractor by the valve supplier pre-assembled with the valve and actuator as a single unit. See specification section 170140 for electric actuators.

2.3 REMOTE OPERATORS

A. Where Required: Where valve operators are located below a platform, within a vault, excessively high, or difficult to access locations, Contractor shall provide extensions to allow remote operation of the valve. Where operated from the platform, remote operator shall allow valve actuation without removal of the platform's grate or valve vault cover. Select type of remote operator based on the following situations:

1. Where valve is located in a permanently dry, non-buried location, and operated from above, provide a handwheel extension.
2. Where valve is located in a wet location or buried, and operated from above, provide solid bar valve stem with gear actuator (where required) mounted top-side.
3. Where valves are located higher than 72-inches above the finished floor, Contractor shall provide valves with chain-wheel operators.

B. Handwheel Extensions: Typically install handwheel extensions on gear actuated valves where operated from above. Extensions to be of Type 316 stainless steel stock. Where required to prevent excessive movement in long-stemmed situations, provide a top-end mount, and intermediate supports and bushings as required. Provide bronze "spinner" on handwheel.

C. Actuator Extensions: Typically install solid bar extensions for top-side location of the valve actuator. Provide valve stem extensions for lever actuated valves and all buried valves. Valve

stem extensions are to be housed in a rigid pipe with mating flanges fabricated for bolting directly to mounting holes on valve and actuator. Stem extensions to be of Type 316 stainless steel stock.

1. Where required to prevent excessive movement in long-stemmed situations, provide a top-end mount with intermediate supports and bushings.
2. If a top-end mount and intermediate supports are required, provide universal joints at each end where stem extension mates with valve and gear stems.
3. Where the length a solid-bar extension cause excessive wind-up during operation, a custom designed large diameter tube with special intermediate mounts shall be provided.

D. Off-Set Extensions: To overcome obstacles in the installation of a straight stem extension, and articulated extension, manufactured specifically for that purpose may be installed. Supplied by Trumbull, www.trumbull-mfg.com; or approved substitute. Custom off-set stem extensions may consist of the following:

1. Extension Stem.
2. Stem Connectors.
3. Torque Tube Assembly and/or Thrust Collar.
4. Miter Gear Assemblies or Universal Joints.
5. Coupling to Valve.

E. Chain Wheel Operators: Typically install for actuation of overhead valves. Capsulated chain wheel on gear operator. Gear operators shall be as otherwise specified. Provide with stem extension as required to eliminate any chaffing by the chain on piping or equipment below the valve. Provide a continuous linked chain to within 12 to 24-inches above floor.

F. Coatings: All exposed ferrous metal parts shall be delivered with a factory applied corrosion resistant coating as previously specified in subsection 2.1. Stem housing pipes are to be coated both internally and externally.

2.4 PVC BUTTERFLY VALVES

A. Requirement: Industrial grade butterfly valve suitable for saltwater use and installation between 150 psi class flanges with wafer body. Sizes 2.5” and larger. All disks shall open into Schedule 80 PVC pipe without interference or modification.

B. Typical Materials:

1. Disc: Typically PVC. PVDF for heavy abrasive conditions. Polypropylene (PPL) shall not be used for chlorinated, brominated, ozonized, or oxidized conditions. PP or PVDF where recommended by manufacturer and PVC is not available. May be PDCPD composite plastic where larger than 24-inch diameter.
2. Shaft: Type 316 stainless steel.
3. Seat: EPDM.
4. Seals: EPDM.
5. Body: PVC or PP with composite glass filament.

C. Materials where “Teflon” valves are specifically called for in ozonized water situations:

1. Disc: Solid Teflon (PTFE), or Teflon covered plastic.
2. Shaft: Type 316 stainless steel.
3. Seat: Teflon or PTFE.
4. Seals: Viton or Teflon.
5. Body: Teflon or PTFE where wetted, or PVC or PP with composite glass filament, where not wetted.

D. Lug Requirement: Provide Type 316 SS threaded lug inserts in at pump suction and filter discharge lines, isolation valves for auxiliary equipment, and where specifically called for on the drawings. Otherwise, provide wafer style bodies without drilled lugs at typical in-line locations.

E. Actuators: Valves are to be installed with actuators as specified above in subsection 2.2.

F. Manufacturer: (Valves shall be supplied with necessary options to meet materials and operator requirements.)

1. *ASAHI/AMERICA*, Malden, MA (781) 321-5409 Type 57 (wafer), Type 57IL (Lug), or Type 75;
2. *GF Piping Systems*, Tustin, CA (800) 854-4090 www.gfpiping.com Type 578 Lug Style where required;
3. *Hayward Flow Control*, Clemmons, NC Phone (888) 429-4635 www.haywardflowcontrol.com BYV Series (1.5-inch thru 12-inch diameter), BYB Series (14-inch thru 24-inch);
4. No substitutes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractor shall supply all materials and labor for the complete installation of all valves, actuators and other specified equipment for a complete workable system in accordance with Manufacturer's recommendations.

B. All disks shall open into pipe openings without interference.

C. Typically butterfly valves shall be installed with the shaft in a horizontal position, unless otherwise noted.

1. Butterfly valve stems shall be in the horizontal position for the following installations:
   a. Where indicated on the Drawings in a horizontal position.
   b. Where there is a concern with debris flowing through the pipe — all tank “return” valves and “drain” valves.
   c. For installation where there is not a heavy electric actuator mounted on the valve.
   d. Where a horizontal stem orientation is required for access and operations of the valve.
   e. Where the valve is installed overhead and a chainwheel operator is required.
2. Butterfly stem may be in the vertical position for the following installations:
   a. Where valves are flowing clear filtered water and more suitable in the vertical position, such as at the discharge of deaeration towers or other clear-water basins, where valves are equipped with heavy electric actuators.
   b. Where a vertical stem orientation is required for access and operation of the valve.
   c. Where indicated on the scale Drawings with the stem vertical and an actuator on top of the valve.

D. Where valves cause excess strain or deflection, extra supports shall be provided in addition to the spacing recommended by the pipe Manufacturer for an uninterrupted length of pipe.

E. Where valves create a "raised face" condition, it may be necessary to add an appropriate backing ring or shim. If the Manufacturer of the flange recommends additional reinforcement, backing rings or shims shall be provided in accordance with Section 170010.

F. Where “wafer” or “lug” type butterfly valves are adjacent to the flexible coupling, use of a solid spacer flange is required to assure a positive sealing surface for the flex coupling and mating to the seal of the valve. (Spacer flange is not required for flanged butterfly valves.)

G. Where the exact location of a valve is not shown, it shall be installed in an accessible place and as directed by the Owner's Representative.

H. Valve operators shall be placed so as not to interfere with nearby piping and equipment and to facilitate operation. The operator shall be orientated to allow visual inspection of the valve position indicator from the service corridor path. Excessive deflection in the extension during normal operation, as determined by the Owner’s Representative, shall be corrected immediately by the Contractor at no additional cost to the Owner.

I. Where valves are equipped with a chain wheel operator, valve shall be mounted so the position indicator is visible while operating the chain.

J. Install intermediate supports for valve operator extensions as recommended or required by valve Manufacturer.

K. Fasteners:

1. Install valves using only Type 316 stainless hex-head bolts, and washers per Section 170316. Substitution with “all-thread” is not an acceptable substitute.
2. Nuts may be bronze material to prevent galling with stainless steel bolts; otherwise, install with stainless steel nuts and anti-seize compound.
3. Flat washers are required under all bolt and nut heads with an additional, split-ring lock washer under the nut side or as specifically recommended by the fitting Manufacturer.
4. Lug type butterfly valves shall have separate hex head bolts securing flanges from both sides. Where lug valves are permanently or temporally installed in a dead-end location, securing bolt threads shall extend completely through the valve’s threaded lug. Threads of connecting bolts shall be lubricated with grease or an anti-seize compound prior to installation.

END OF SECTION

SECTION 170144 - BALL VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. The size and location of all valves shall be as indicated on the Process and Instrumentation Diagrams and/or scale drawings. The General Conditions apply to this Section as fully as if repeated herein.

1.2 COORDINATION

A. Mechanical contractor shall determine where “oversized” electric valve actuators may place excessive forces on valve/piping and provide separate support of such actuators as required. This situation is not uncommon for small actuated valves.

B. Electric Actuators: Valves with electric actuators, shall be delivered to the Contractor by the valve supplier pre-assembled with the valve and actuator as a single unit. See specification section 170140 for electric actuators.

1.3 SUBMITTAL

A. Submit complete information describing all dimensions and materials of valve composition.

B. Submit details of factory and custom designed operator extensions, mounts, extension supports and bushings where required.

1.4 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010.

PART 2 - PRODUCTS

2.1 REMOTE OPERATORS

A. Where Required: Where valve operators are located below a platform, within a vault, excessively high, or difficult to access locations, Contractor shall provide extensions to allow remote operation of the valve. Where operated from the platform, remote operator shall allow valve actuation without removal of the platform's grate or valve vault cover.

B. Provide lever extensions, actuator extensions, sleeved cable operators, or chain wheel operators as required for the specific situation.

C. Coatings: All exposed ferrous metal parts shall be delivered with a factory applied corrosion resistant coating.

2.2 PVC/CPVC TWO-WAY BALL VALVES

A. Location: Standard ball valves typically used in saltwater exhibit piping and PVC/CPVC piping installations.

B. Sizes: 2" and smaller.

C. Design: Standard 2-way open/close ball valves, PVC/CPVC bodied with Teflon seats and Viton or EPDM seals. Valves to be suitable for 150 psi operating pressure at 75 deg F.

1. Typically, "True Union" type.
2. Body and Ball: PVC in PVC piping and CPVC in CPVC piping.
3. Provide "Single Entry" or "Utility" (non-true union) ball valves at end of service locations such as vent and drain lines.

D. Manufacturer:

1. *ASAHI/AMERICA* Malden, MA (781) 321-5409;
2. *GF Piping Systems* Tustin, CA (800) 854-4090 www.gfpiping.com;
3. *Hayward Industrial Products Inc.,* Elizabeth, NJ (908) 351-5400;
4. or approved substitute.

2.3 PVC/CPVC FLOW CONTROL BALL VALVES AKA LINEAR FLOW

A. Location: Ball valves, for proportional flow control, installed only at locations called out on the Drawings as "Linear" type where there is one-way directional flow.

B. Design: Ball valves manufacturer for linear increasing water flow in equal proportion to the degree open. PVC/CPVC bodied with Viton or EPDM seals, Teflon seats, and EPDM or FKM O-Rings. Valves to be suitable for 150 psi operating pressure at 75 deg F.

1. "True Union" type.
2. Ball shall be full-port design and full sphere shape.
3. Body and Ball: PVC in PVC piping and CPVC in CPVC piping.

C. Manufacturer:

1. *ASAHI/AMERICA* Malden, MA (781) 321-5409;
2. *Hayward Industrial Products Inc.,* Elizabeth, NJ (908) 351-5400***;***
3. or approved substitute.

2.4 PVC PVC LAB COCKS & GAUGE COCKS

A. Lab Cocks: Located at sample taps and where otherwise shown on the Drawings. PVC uni-body type lab cock with lever handle. 1/4-inch male threaded pipe connection with 90-degree elbow and hose barb fittings at outlet end.

B. Gauge Cocks: Located at taps for pressure gauges. PVC uni-body type gauge cock with lever handle. Longitudinal in-line design with two 1/4-inch female threaded pipe connections.

C. Materials: PVC body with EPDM seats and seals.

D. Manufacturer: As may be available from *ASAHI/AMERICA*; *GF Piping Systems*; *Hayward;* or approved substitute.

2.5 STAINLESS STEEL 3-PIECE BALL VALVES

A. General: Swing-out 3-piece type ball valves suitable for the transmission of three percent ozone gas in air at 120 deg F.

B. Materials:

1. Body & Ball: Forged and machined Type 316 (ASTM A 351) stainless steel.
2. Packing: *Teflon*, reinforced PTFE, or graphite.
3. O-ring or Seats: Viton PTFE, or reinforced PTFE
4. Trim: Type 316 stainless steel.

C. Connection: ANSI B16.11 socket weld tube end connection, female pipe thread.

D. Appurtenances: Supply each valve with universal mounting bracket and hinge for swing-out valve service, except for panel mounted valves.

E. Manufacturer:

1. *Whitey Company* (Swagelok) (Series 63) Highlands Heights, OH;
2. *Worcester* (Mizer Valve) Marlborough, MA (617) 481-4800;
3. *Neles-Jamesbury* (Series 3) Worcester, MA (508) 852-0200;
4. Apollo Stainless Steel 3-Piece Ball Valve *Conbraco Industries, Inc*. Matthews, NC (704) 841-6000 www.conbraco.com;

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractor shall supply all materials and labor for a complete workable system in accordance with Manufacturer's recommendations.

B. Where valves cause excess strain or deflection, extra supports shall be provided in addition to the spacing recommended by the pipe Manufacturer for an uninterrupted length of pipe.

C. Where the exact location of a valve is not shown, it shall be installed in an accessible place and as directed by the Owner's Representative.

D. Install flow control ball valves only where there is one-way water flow and for water flowing in the direction of the arrow printed on the valve body.

E. Valve operators shall be placed so as not to interfere with nearby piping and equipment and to facilitate operation. The operator shall be orientated to allow visual inspection of the valve position indicator from the service corridor path.

F. Install intermediate supports for valve operator extensions as recommended or required by valve Manufacturer.

1 END OF SECTION

SECTION 170146 - GLOBE VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. The size and location of all valves shall be as indicated on the Process and Instrumentation Diagrams and/or scale drawings. The General Conditions apply to this Section as fully as if repeated herein.

1.2 SUBMITTAL

A. Submit complete information describing all dimensions and materials of valve composition.

B. Submit details of factory and custom designed operator extensions, mounts, extension supports and bushings where required.

1.3 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010.

PART 2 - PRODUCTS

2.1 PVC GLOBE VALVES

A. General: Designed by the manufacture specifically for frequent throttling applications. Valve shall be capable of sustained throttling with minimum seat erosion. May be standard configuration or Y-Pattern design.

B. End Connections: Bodies shall be flanged with 150 psi ANSI B15.1 bolt pattern.

C. Pressure Rating: No less than full vacuum rating. Two-inch and smaller rated not less than 150 psi pressure and larger than 2-inch size rated not less than 90 psi pressure.

D. Materials: PVC body with EPDM, Viton or Teflon seals.

E. Manufacturer:

1. *ASAHI/AMERICA* Malden, MA (781) 321-5409;
2. *Hayward Industrial Products Inc*. Elizabeth, NJ (908) 351-5400;
3. *Spears Manufacturing Co*. Sylmar, CA (818) 364-1611;
4. Or approved substitute.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractor shall supply all materials and labor for a complete workable system in accordance with Manufacturer's recommendations.

B. Fasteners:

1. Install valves using only Type 316 stainless hex-head bolts, and washers per Section 170316. Substitution with all-thread is not an acceptable substitute.
2. Nuts may be bronze material to prevent galling with stainless steel bolts; otherwise, install with stainless steel nuts and anti-seize compound.
3. Flat washers are required under all bolt and nut heads with an additional, split-ring lock washer under the nut side or as specifically recommended by the fitting Manufacturer.

C. Where valves cause excess strain or deflection, extra supports shall be provided in addition to the spacing recommended by the pipe Manufacturer for an uninterrupted length of pipe.

END OF SECTION

SECTION 170148 - DIAPHRAGM VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. The size and location of all valves shall be as indicated on the Process and Instrumentation Diagrams and/or scale drawings. The General Conditions apply to this Section as fully as if repeated herein.

1.2 SUBMITTAL

A. Submit complete information describing all dimensions and materials of valve composition.

B. Submit details of factory and custom designed operator extensions, mounts, extension supports and bushings where required.

C. Submit factor warranty.

1.3 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010.

PART 2 - PRODUCTS

2.1 DIAPHRAGM VALVES FOR LIQUID SERVICE

A. General: Designed specifically for throttling of sludge slurry and/or corrosive liquids.

B. End Connections: Bodies shall be flanged with ANSI 150 lb. bolt pattern.

C. Pressure Rating:

1. Where installed in sludge and vacuum service line, shall have options as required for vacuum service.
2. Minimum 75 psi positive pressure rating.

D. Materials: PVC body with EPDM diaphragm.

E. Manual Actuators: Provide with standard non-rising round handle.

F. Manufacturers:

1. *ASAHI/AMERICA,* Malden, MA (781) 321-5409;
2. *GF Piping Systems,* Tustin, CA (800) 854-4090 - ;
3. *Hayward Flow Control,* Clemmons, NC (888) 429-4635 www.haywardflowcontrol.com;

4. or approved substitute.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractor shall supply all materials and labor for a complete workable system in accordance with Manufacturer's recommendations.

B. Fasteners:

1. Install valves using only Type 316 stainless hex-head bolts, and washers per Section 170316. Substitution with “all-thread” is not an acceptable substitute.
2. Nuts may be bronze material to prevent galling with stainless steel bolts; otherwise, install with stainless steel nuts and anti-seize compound.
3. Flat washers are required under all bolt and nut heads with an additional, split-ring lock washer under the nut side or as specifically recommended by the fitting Manufacturer.

C. Where valves cause excess strain or deflection, extra supports shall be provided in addition to the spacing recommended by the pipe Manufacturer for an uninterrupted length of pipe.

END OF SECTION

SECTION 170155 - CHECK VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. The size and location of check valves shall be as indicated on the Process and Instrumentation Diagrams and/or scale drawings. The General Conditions apply to this Section as fully as if repeated herein.

1.2 COORDINATION

A. Before ordering valves, the Contractor shall verify the mating of valves to selected flanges or other connections. Contractor shall take all necessary measures to provide proper clearances, including verification of swing out requirements for discs of wafer-type check valves, and coordinate valve selection with dimensions of adjoining piping. Contractor shall provide additional spacers/shims, or otherwise select valves and fittings, for completely satisfactory installation.

B. Contractor shall coordinate configuration of check valves, and/or piping arrangement, or vertical or horizontal valve orientation.

1.3 SUBMITTAL

A. Submit complete information describing all dimensions and materials of valve composition.

B. Submit a schedule of all check valves, listing the horizontal or vertical orientation, identified by location and service.

C. Submit details of factory and custom designed linkages, lever arms, and springs.

1.4 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010.

PART 2 - PRODUCTS

2.1 CHECK VALVES FOR LIQUID SERVICE

A. Check Valves 2.5-inch Diameter and Larger: Wafer, swing-type check valve manufactured of PVC.

1. Swing type wafer check valve, with spring, manufactured with one-piece body. 8-inch size and smaller rated for 150 psi pressure at 70 deg F. 10-inch size and larger rated for not less than 85 psi pressure at 70 deg F.

2. Valves shall have a one-piece disc and shaft design suitable for either horizontal or vertical installations. Equipped with spring for assist of disc closure (factory option as required).
3. Body and disc construction shall allow for nearly complete opening of disc without the need for additional spacers. Disk shall fully open with a pressure of 0.5 PSI or less. Minimum flow coefficients shall be as follows:

    a. 3-inch size, minimum Cv = 137
    b. 4-inch size, minimum Cv = 200
    c. 6-inch size, minimum Cv = 663
    d. 8-inch size, minimum Cv = 1225
    e. 10-inch size, minimum Cv = 1750

4. Materials:

    a. Body: PVC plastic.
    b. Seals: FKM (Viton) or EPDM rubber.
    c. Spring: Hastelloy, Inconel, or manufacturers selected material with an ETFE coating.

5. Installation with full-face gaskets, in addition to the O-ring seal, can help to prevent leakage.
6. Manufacturer:

    a. *Hayward Flow Control,* (***Special Ordered*** with Hastelloy spring Material) Clemmons, NC (888) 429-4635;
    b. *ASAHI/AMERICA,* (***Special Ordered*** with specified spring) Malden, MA (781) 321-5409;
    c. Or approved substitute.

B. Check Valves Two-Inch Diameter and Smaller:

1. "Y" type check valve, PVC body, with threaded end connections and hex end-cap with Viton O-ring cap seal. C_v factor for 1.5-inch size shall not be less than 40 GPM at one PSI. Ball type check valves are not an acceptable substitute. Manufacturer: Hayward Flow Control, Clemmons, NC Phone (888) 429-4635; or approved substitute.
2. Clear plastic valve, true-union end connections, with EPDM seals. “Swing Check” design with weighted disc and no internal spring. By *Spears Manufacturing*, no substitutes.

2.2 CHECK VALVES FOR OZONE GAS SERVICE

A. Stainless Steel “Soft Seat” Check Valves (0.25 to 2" diameter): Designed specifically for corrosive environments for protection against reverse flow. Valve shall be of suitable materials for ozone gas flow and protection against seawater reverse flow.

1. Pressure Rating: 125 psi saturated steam.
2. Flow Coefficient: 0.5-inch valve design shall have minimum CV of 1.40 gpm/psi; other valve sizes shall have proportional CV values.
3. Body: ASTM A351 Stainless Steel or better.
4. Check Seat: “Soft Seat” Viton 1-inch and smaller, “Cone Ball” where larger.
5. Spring: Type 316 stainless steel or better.
6. Manufacturer: *Conbraco Industries, Inc*. Matthews, NC (704) 841-6000 www.conbraco.com; or approved substitute.

2.3 DOUBLE DOOR CHECK VALVES

A. "Technocheck" elastomer-hinged wafer style check valve. Materials shall be ozone gas resistant and serviceable for air temperatures up to 400 degree Fahrenheit. For installations at discharge of air blowers, ozone off-gas venting, and similar locations.

B. Materials:

1. Body: Wafer style, ASTM A 351, Type 316 stainless steel, for installation between ASME 150 lb. flanges.
2. Disc: Double-door, ASTM A-351, Type 316 stainless steel.
3. Hinge & Seals: FKM/Viton Rubber, -20 to 400 deg. F temperature rating.
4. Fasteners & Screws: Type 316 stainless steel.

C. Spring: No spring for vertical up-flow installations. Provided with Type 316 stainless steel spring for horizontal installations.

D. Performance & Installed Conditions:

1. Pressure: 150 lb. pressure class. Installed operating pressure is 0 to 25 psig.
2. Temperature Rating: 400 deg. F, operating temperature is less than 200 deg. F.
3. Flow Coefficient: (air Cv) of 160 SCFM at 0.1-psi differential for 2-inch valve

E. Model & Manufacturer: Style 5296-316 by *Techno Corporation*, Erie, PA (814) 838-4561 may be supplied by www.usvalve.com ; or approved substitute.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractor shall install check valves as required for a complete workable system in accordance with Manufacturer's recommendations.

B. Provide gaskets and sealants as recommended by the Manufacturer, as required, and as specified in Section 170010.

C. Fasteners:

1. Install valves using only Type 316 stainless hex-head bolts, and washers per Section 170316. Substitution with "all-thread" is not an acceptable substitute.
2. Nuts may be bronze material to prevent galling with stainless steel bolts; otherwise, install with stainless steel nuts and anti-seize compound.
3. Flat washers are required under all bolt and nut heads with an additional, split-ring lock washer under the nut side or as specifically recommended by the fitting Manufacturer.

D. Where disks open into pipes, take all measures necessary to eliminate interference problems or situation where the disk may bump into and damage the pipe wall.

E. Do not install check valves directly on pump discharge flanges. Provide concentric tapered reducers where shown at pump discharges for mounting of check valves or extension pipe spool. If reducing fittings are not required at pump discharges, install a pipe spool not less than two (2) pipe diameters in length for installation of check valves remote of the pump discharge flange.

1 END OF SECTION

SECTION 170157 - NEEDLE TYPE VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. The size and location of all valves shall be as indicated on the Process and Instrumentation Diagrams and/or scale drawings. The General Conditions apply to this Section as fully as if repeated herein.

1.2 SUBMITTAL

A. Submit complete information describing all dimensions and materials of valve composition.

B. Submit air flow rate curves showing flow rate vs. pressure drop for all needle valves and regulating valves used in conjunction with the ozone gas injection system.

1.3 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010.

PART 2 - PRODUCTS

2.1 STAINLESS STEEL NEEDLE VALVES

A. General: Designed for regulating of flows of corrosive ozone gas (3% max.) in air (assume same density and gas characteristics as air at 70 deg F).

B. Materials: Body and stem constructed of Type 316 stainless steel with Teflon packing.

C. Size & Coordination: Valve size to be as indicated on Drawings, if not indicated, valve to be same size as adjacent piping. Orifice and flow rate sizing must be coordinated with actual purchased equipment sizing. Submit air flow curves for review for each location.

1. Up to 37 SCFH: 3/8-inch Whitey "1" *Integral Bonnet Needle Valve,* with 0.172-inch diameter orifice and regulating type stem, with max. C_V = 0.37; where indicated on P&ID for gas flow rates up to but not exceeding 37 SCFH.
2. Up to 110 SCFH: 3/8-inch Whitey "1" *Integral Bonnet Needle Valve,* with 0.250-inch diameter orifice and regulating type stem, with max. C_V = 0.73; where indicated on P&ID for gas flow rates up to but not exceeding 110 SCFH.
3. Up to 290 SCFH: 3/8-inch or ½-inch Whitey "6N" *Severe Service Union Bonnet Valve,* with 0.250-inch diameter orifice and regulating type stem, with max. C_V = 0.86; where indicated on P&ID for gas flow rates up to but not exceeding 290 SCFH.
4. Up to 550 SCFH: ½-inch Whitey "18" *Integral Bonnet Needle Valve,* with 0.375-inch diameter orifice and regulating type stem, with max. C_V = 1.80; where indicated on P&ID for gas flow rates up to but not exceeding 550 SCFH.

5. Up to 650 SCFH: ½-inch, ¾-inch or 1-inch Whitey "12N" *Severe Service Union Bonnet Valve,* with 0.437 inch diameter orifice and regulating type stem, max. C_V = 2.2; where indicated on P&ID for gas flow rates up to but not exceeding 650 SCFH.

D. Connection: Male NPT. Provide adjacent true-union fitting or coupling to allow for quick replacement of valve.

E. Manufacturer: Whitey Company (Swagelok), Willoughby, OH www.swagelok.com; or approved substitute.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractor shall supply valves, materials, and labor for a complete workable system in accordance with Manufacturer's recommendations.

END OF SECTION

SECTION 170220 - PVC/CPVC PIPE AND FITTINGS

PART 1 - GENERAL

1.1 IDENTIFICATION

A. Schedule 40 PVC piping is generally used for exhibit water transmission piping and where designated with the PROCESS-PVC-SIZE tag number.

B. Schedule 40 CPVC piping is to be used where water temperatures may exceed 140 deg F and where designated with the PROCESS-CPVC-SIZE tag number.

C. Schedule 80 CPVC piping, manufactured with the specified of *Corzan*® resin, is to be used for ozone in-solution piping and ozone off-gas piping and where designated with the PROCESS-CPVC-SIZE tag number.

D. Clear Schedule 40 PVC where “Clear Spools” are called for and other situation where clear PVC is called for on Drawings.

E. PVC Conduit: See specification 170261 for PVC conduit, and long-sweep fittings, used for dual-containment of Teflon tubing for ozone gas.

1.2 SUMMARY

A. Note, requirements given for PVC in this specification shall apply equally for CPVC.

B. The General Conditions apply to this Section as fully as if repeated herein.

C. Installed piping shall be pressure tested by Contractor per specification Section 170010.

1.3 SUBMITTALS

A. Submit information describing all dimensions and materials of fittings.

B. For all fabricated fittings, the Manufacturer shall submit a quality assurance (QA) manual.

C. Submit name of proposed PVC field supervisor, training certificates, and resume of completed thermoplastic piping projects.

D. Submit PVC solvent cements and PVC primer proposed for the piping. Solvent cement manufacturer shall provide cement selection and application procedures for review prior to starting work.

1.4 FIELD COORDINATION & QUALITY CONTROL

A. Complete System: It is the Contractor's responsibility to provide piping by means that account for all necessary coordination, including, but not limited to: water stops, oversize sleeves, pipe supports, valves and other attachments, etc.

B. Special Conditions:

1. Where required at non-standard off-sets and angle elbows, the contractor may elect the use of “Special Fabricated Fittings.”
2. Where required to meet short laying length conditions (*typical* at filter discharges, manifold connections and other restrictive areas) the Contractor shall obtain fittings available from specified manufacturers with short laying lengths.

C. Pressure Test: Pressure test with water in accordance with Section 170010. Pressure testing of PVC piping with compressed air is not allowed. Provide pipe extensions and temporary caps as necessary for pressure testing requirements specified in Section 170010. Contractor shall coordinate timing of pipe pressure testing with Owner’s representative for recording of pressure test logs.

D. Field Supervision: Contractor shall ensure that one person on their staff is the designated supervisor for fabrication and installation of all PVC piping. This person shall be on site supervising or performing all thermoplastic piping work to ensure continuity in quality of the installation. The designated field PVC supervisor shall have completed manufacturer’s training in the installation of thermoplastic piping systems and shall provide a resume listing at least five (5) thermoplastic piping projects.

E. Flexible PVC: Coordinate with the Aquarium animal husbandry staff where used in exhibit water tanks.

PART 2 - PRODUCTS

2.1 PIPE & FITTING PRESSURE RATINGS

A. The pressure ratings for Schedule 40 pipe and fittings shall be as follows:

1. Sch 40 pipe shall sustain a minimum of 120 psi at 73 deg F.
2. Solvent cemented joint fittings 4-inch diameter and smaller shall sustain a minimum of 130 psi at 73 deg F.
3. 6-inch and 8-inch diameter cemented joint fittings shall sustain a minimum of 90 psi at 73 deg F or be structurally modified for a higher pressure rating where necessary.
4. 10-inch diameter and larger Sch 40 cemented joint fittings shall sustain a minimum of 120 psi at 73 deg F.
5. Threaded joints for Schedule 40 pipe and fittings are only allowed for 2-inch diameter material and shall sustain a minimum of 90 psi at 73 deg F. All other threaded joint fittings shall be Schedule 80 or have the pressure rating verified for the service condition.
6. Fabricated Sch 40 fittings, of all sizes, shall sustain a minimum pressure of 120 psi.

2.2 PVC PIPE & FITTINGS

A. Pipe: All new, solvent welded, polyvinyl chloride (PVC) rigid pressure pipe; PVC pipe made from Class 12454 (formerly Type I, Grade 1) virgin compounds, as defined in ASTM D1784. Dimensions and maximum operating pressure shall conform to ASTM D-1785.

B. Cement: Solvent weld in accordance with ASTM D-2855 and/or ASTM D-2564.

C. Special Fabrications: Special fabrications such as manifolds shall be designed to carry stresses developed with the "Free Ends" condition, without thrust blocking or backfill when hydrostatic pressure testing is performed.

D. PVC Fittings:

1. Base Material: Of the same schedule rating as adjoining pipe, polyvinyl chloride (PVC) made from Class 12454 compounds, containing no fillers or re-grounds in accordance with ASTM D-1784.
2. Self-Supporting Design: All fittings shall be designed to carry stresses developed with a "Free Ends" condition when hydrostatic pressure testing is performed.
3. Construction: Fittings 12-inch diameter and less for common angles shall be "molded" type. Where special angles or manifold configurations are required, the fittings may be of the fabricated type.
4. Identification: Fittings shall have identifying markings per applicable ASTM Standards.

E. PVC Fittings Manufactured by:

1. *Dura Plastic Products Inc.* Beaumont, CA (909) 845-3161 www.duraplastic.com ;
2. *Chemtrol Division of Nibco* Elkhart, IN (800) 343-5455 www.nibco.com;
3. *George Fischer Harvel USA* (800) 854-4090 or (714) 731-8800 www.gfpiping.com;
4. *Spears Manufacturing Company* Sylmar, CA (818) 364-1161 www.spearsmfg.com;
5. *Eslon Thermoplastics* Pineville, NC (704) 889-2431;
6. or approved substitute.

F. Flanged Reducers: At pump discharges, and other locations identified on the Drawings, provide 150 lb. concentric flanged FRP composite reducer fittings. Thickness of the FRP flange shall not be less than as shown on Table 5 of NBS-PS15-69 for 150 psi design pressure. By *Conley Corporation* Tulsa, OK; *Smith Fibercast* Little Rock, AR; *Ram Fiberglass* Chino, CA ramfiberglass@aol.com; or approved substitute.

G. Special Fabricated Fittings: Special fabrications shall be made where non-standard bend elbows or where multi-outlet manifolds are required.

1. Manufactured from PVC pipe stock made in the U.S.A. conforming to applicable ASTM Standards D1785 or ASTM D2241. Wall thickness-loss in fabrication shall not exceed 10% without additional reinforcement.
2. All products shall sustain a minimum pressure of 90 psi at 73 deg F.
3. Fabricated fitting sockets shall have an interference fit as required by ASTM D2466 and ASTM D2467.
4. Multi-Outlet Manifolds shall be fabricated to match dimensions, with inlets, outlets, reductions, socket ports, and threaded connections as shown on the Contract Drawings.
5. For custom bend elbows, change of direction fittings shall not exceed a 1-degree plus/minus variance from the angles called out, or implied, on the Contract Drawings or as submitted on shop drawings.
6. The manufacture shall be responsible for secure and permanent bonding of all parts. Bonding may consist of using the manufacturer's proprietary bonding agent; or WELD-ON 811 2-part high strength reactive adhesive, by *Weld-On Adhesives, Inc.* www.weldon.com; or presision hot-air welds, and/or over-wrapping or floc with fiberglass and resin.
7. Finished products shall meet factory Q.A. testing requirements.
8. All fittings shall be marked with the specific part number and marked with certification as fabricated by the submitted manufacturer.
9. Manufacturer: *Spears Manufacturing Company* Sylmar, CA (818) 364-1611 www.spearsmfg.com; or approved substitute.

2.3 CPVC PIPE & FITTINGS

A. CPVC Pipe & Fittings: Shall be Schedule 80 manufactured of *Corzan*® CPVC, or "EverTUFF" by *Spears Manufacturing,* with the following material properties:

1. Specific Gravity: 1.55 nominal
2. Hardness: 119 minimum R-Scale per ASTM D785
3. Notched Izod Impact: 2.9 ft-lbs / inch notch test, minimum per ASTM D256
4. Tensile Strength: 7,320 psi, minimum per ASTM D638
5. Flexural Strength: 13,200 psi, minimum per ASTM D790
6. Heat Distortion Temperature: 212 °F, minimum per ASTM D648
7. Cell Classification: 24448 or 23558, per ASTM C 1784

B. CPVC Pipe: All new, solvent welded, chlorinated polyvinyl chloride (CPVC), rigid pressure pipe; made from (Type IV Grade I) virgin compounds, as defined in ASTM D1784. Dimensions and maximum operating pressure shall conform to ASTM F441.

C. CPVC Fittings: Of the same schedule rating as adjoining pipe, chlorinated polyvinyl chloride (CPVC) made from Class 23447 compounds, containing no fillers or re-grounds in accordance with ASTM D-1784. Fittings shall be molded type and designed to carry stresses developed with a "Free Ends" condition. Fittings shall have identifying markings per applicable ASTM Standards.

D. Solvent Cement: Use only the piping product manufacturer's recommendations for solvent welding cements, such as Type 724 for 12-inch diameter and smaller and Type 729 for the larger sizes by *IPS Weld-On* Compton, CA www.ipscorp.com or equal.

E. CPVC Pipe Manufacturers:

1. Charlotte Pipe & Foundry Co. Charlotte, NC (800) 438-6091;
2. *Harvel Plastics, Inc.* Easton, PA (610) 252-7355.

F. CPVC Fittings Manufacturers:

1. Charlotte Pipe & Foundry Co. Charlotte, NC (800) 438-6091;
2. *IPEX* Pineville, NC (800) 463-9572;
3. *Nibco, Inc.* Elkhart, IN (800) 642-5463;
4. Spears Manufacturing Company Sylmar, CA (818) 364-1161 *www.spearsmfg.com*.

2.4 FLEXIBLE PVC

A. Solvent-Weldable flexible Schedule 40 PVC pipe matching cemented PVC fitting dimensions. By FlexPVC www.flexpvc.com or equal. This specification is to apply for in exhibit tank end-of-line piping to alleviate difficulties with rockwork and the need expressed by the Aquarium staff.

2.5 CLEAR PVC PIPE

A. Solvent-Weldable clear Schedule 40 PVC pipe matching cemented PVC fitting dimensions. By IPEX; or equal. Installed only where called out on the Drawings.

2.6 PIPE JOINTS

A. Solvent-Welded Joints: Straight pipe and typical PVC fittings shall be solvent-welded, bell and spigot joints unless otherwise noted. Straight-end pipe with solvent-welded joining is acceptable. "O-Ring" joints are not acceptable.

1. Solvent Cement: Use only the piping product manufacturer's recommendations for solvent welding cements.
2. Chemical Service: For chlorine, acid, and other piping for chemical service in PVC/CPVC piping, use Weld-On 724 by IPS Corporation; CPVC- 24 by Spears Manufacturing Co; or other approved solvent cement.

B. Flange Fittings: Where pipe joins to a dissimilar material, provide a flanged coupling, unless otherwise shown, socket welded, 150 lb. bolt pattern, with extra heavy reinforcing in the flange to prevent cracking. Companion flanges two-inch diameter and larger shall be "Vanstone" type.

C. True Union Couplings: Where true union couplings are used for special situations, the couplings shall be 100-percent PVC material and not have external metal reinforcement bands.

D. Fabricated Telescoping Expansion Joints:

1. Use: For telescoping installations, adjustable "Hartford Loops," and to meet requirements for pipe expansion and contraction. May also be spliced into a removed pipe segment for use as a repair coupling where specifically approved by the Owner's representative.
2. Design: PVC coupling with telescoping design, with non-binding design, and no less than two (2) wiper O-rings. Where temperatures may dip below freezing, provide with EPDM rubber O-rings. Where temperatures will always be above freezing, provide with FKM/Viton O-rings. Minimum 12-inch travel model required for all Hartford Loop installations
3. Manufactured by: *Spears Manufacturing Company*, Sylmar, CA.

E. Full-Circle Stainless Steel Repair Clamps:

1. Use: Do not use for standard construction. Use only for pipe repairs where no other means is possible, only with approval or the Owner or the Owners representative, or where specifically called for on the Drawings.
2. Design: All stainless steel split-clamp coupling, with nitrile or EPDM gaskets, no less than 7.5-inches long, with Type 316 stainless steel fasteners.
3. Manufacturers: Type 257 by *Smith-Blair*, Type 300 by *Baker*, or by *Straub*.

F. Bulkhead Fittings (Tank Adapters):

1. Use: Used for adding additional ports to plastic walled tanks.
2. Design: Manufactured with a screw-on lock-ring and EPDM rubber gasket to make a non-metallic mechanical connection through a tank wall. Made of heavy-duty PVC construction with a bell type outlet to maximize the free flow of water.
3. Manufactured by: *Spears Manufacturing Company*, Sylmar, CA; *Harrington Industrial Plastics Inc.* Chino, CA (909) 597-8641 www.harringtonplastics.com; *Hayward Industrial Products Inc.* Elizabeth, NJ (908) 351-5400 www.haywardindustrial.com ; or *Ryan-Herco Products Corporation*, Burbank, CA (800) 848-1141 www.ryanherco.com.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. See also Section 170010 for pipe installation requirements; including limitations for PVC piping installed in CDF encasement, and compliance with AWWA Manual M23 and AWWA C605.

B. Typical PVC joints are to be solvent-welded except where the pipe abuts equipment and valves, or where specifically shown or called for on the plans to be flanged or jointed with special couplings. Provide True-Union or flanged fittings in piping arrangement where necessary to perform servicing of equipment.

C. Joints shall be solvent-weld, in accordance with ASTM D2855 and the pipe manufacturer's instructions, unless otherwise shown. Be sure to use Weld-On 724 or Spears CPVC-24 cement for "chemical duty" PVC and CPVC piping, or approved equal.

END OF SECTION

SECTION 170233 - COMPRESSED AIR PIPING

PART 1 - GENERAL

1.1 USAGE

A. Compressed air piping locations:

1. This specification Section, for non-metallic piping generally used throughout the LSS back areas, near or below saltwater, and other locations where plastic compressed air piping is called for on the Drawings.
2. Use copper piping, per specification Section 170206, for compressed air piping from ozone a air compressors to air receiver, from ozone air receivers to air filters, and other locations where “CU” piping is called for on the Drawings.

1.2 SUMMARY

A. Provide where indicated on the drawings by the designation "CAP". The General Conditions apply to this Section as fully as if repeated herein.

B. The compressed air distribution piping to the project shall be of plastic material and specifically manufactured for compressed air service. PVC is not acceptable by Code for compressed air service. The Contractor shall choose one of the following systems for the compressed air piping.

1. Fusion welded high-density polyethylene (HDPE).
2. Solvent-welded ABS.
3. Push-to-connect ABS.

C. Installed piping shall be pressure tested by Contractor per specification Section 170010.

1.3 SUBMITTAL

A. Submit information describing all dimensions and materials of fittings

1.4 FIELD COORDINATION

A. It is the Contractor's responsibility to provide piping by means that account for all necessary coordination.

B. Contractor shall coordinate timing of pipe pressure testing with Owner’s representative for recording of pressure test logs.

PART 2 - PRODUCTS

2.1 DISTRIBUTION PIPE & FITTINGS

A. Piping shall be shatter resistant and specifically intended by the manufacturer for compressed air service.

1. HDPE Pipe Option: High-density polyethylene designed for operating pressures to 230 psi with a safety factor of 2.2. Color coded blue for compressed air service. Supplied by ASAHI/AMERICA, Malden, MA (781) 321-5409 or (800) 343-3618; or Ryan Herco, Richmond, VA, 818/973-2621; or approved substitute.
2. ABS Pipe Cement-Joined Option: ABS piping rated for not less than 145 psi at 73 °F with integral color coding for compressed air service. Duraplus ABS Air-Line supplied by *Harrington Industrial Plastics, Inc.* Nashville, TN (615) 726-0112; *IPEX* Roseville, CA www.ipexamerica.com or Chem-Aire by *Chemtrol/NIBCO INC.* Elkhart, IN (219) 295-3221, www.nibco.com; or approved substitute.
3. ABS Pipe Push-to-Fit Option: ABS piping rated for not less than 145 psi at 73 °F color coded green for compressed air service. Push-to-fit fittings shall be easily disconnected by means of a simple collar-tool. Submit proposed supplier for review.

2.2 LEADER PIPING

A. Leader piping shall be installed upstream of plastic compressed air piping, and connecting to compressor equipment, and shall be of metallic materials.

1. Installed for a minimum length of 10-ft after air compressors and air blowers for heat dissipation.
2. Pipe: Schedule 10 Type 316 Stainless Steel piping or better. Conforming to ASTM A312 ASME SA312.
3. Fittings: Type 316 Stainless steel threaded fittings are acceptable where flanged fittings are not required for connection to equipment.

PART 3 - EXECUTION (See Section 170010)

END OF SECTION

SECTION 170250 - POLYETHYLENE (PE) PIPE AND FITTINGS

PART 1 - GENERAL

1.1 USAGE

A. The PE pipe and fittings are used for recirculation and filtration of aquatic animal exhibits.

1.2 SUMMARY

A. The General Conditions shall apply to this Section as fully as if repeated herein.

B. The drawings label piping with a PROCESS-MATERIAL-SIZE designation. Provide where indicated on the drawings by the designation "PE." All dimensions are "nominal" pipe sizes per Table 7 of ASTM F714 for IPS sizing.

C. Both straight lengths of pipe and fittings shall be from the same supplier or distributor.

D. This project will require special installation techniques otherwise not required for straight-line-piping run projects. The Contractor is responsible for as many field joints as may be required to meet site requirements. Special techniques may be required where piping is highly fixed, particularly where piping terminates near hydraulic structures.

E. The field personnel making the fusion joints shall be fully trained and/or qualified as specified below.

F. Installed PE piping shall be pressure tested by Contractor per specification Section 170010. This calls for a 3-hour expansion phase with pressure at 90 psi, followed by an 80 psi 1-hour pressure test, among other requirements.

1.3 FIELD COORDINATION

A. The piping shall be manufactured extensively in factory-made-up "spooled" assemblies; however, the Contractor shall allow for sufficient field-fused joints and extra laying lengths to provide for field adjustment.

B. Provide flanges and backing rings with 150 lb. drilling pattern for all valves and other locations shown on the drawings.

C. Typical field joints shall be thermally butt-fused pipe ends or electrofusion couplings. The Contractor provide coordination for over-excavation for butt-fusion machinery and other critical path items. Exposed metal electrodes are not allowed in waters of fish or shark tanks.

D. Contractor must obtain prior approval of Owner before addition of any buried flanged connections not shown on the original Contract Documents.

E. The Contractor shall use procedures developed by the pipe and/or fitting manufacturers that have been proved to produce reliable heat fusion joints; or where manufacturer’s written procedures are lacking, the Contractor shall use heat fusion practices given in ASTM F2620. Approved heat

fusion methods include butt, saddle, and socket heat fusion; however, extrusion welding of pressure pipe connections is not acceptable. Extrusion welding shall only be used for bonding of anchor flanges and other external brackets not related to holding water pressure. Other fusion practices developed by manufacturers shall be submitted for review.

F. It is the Contractor's responsibility to provide piping by means that account for all necessary coordination, including, but not limited to: water stops, oversize sleeves, pipe supports, valves and other attachments, any over-excavation required for fusion machinery or other equipment, etc.

G. Provide pipe extensions and temporary caps necessary for pressure testing requirements specified in Section 170010. Contractor shall coordinate timing of pipe pressure testing with Owner's representative for recording of pressure test logs.

H. Coordinate installation and pressure testing of piping with temperature and thermal limitations given below and in referenced standards.

1.4 QUALITY CONTROL

A. In-Plant Pipe Production Program: Use an in-plant quality control program to monitor production of pipe in compliance with latest ASTM specification to assure compliance with this Specification including maintaining records and supply of copies to the purchaser if requested.

B. Fitting Shop Program: Shall employ in-shop quality control methods to monitor production of fittings in compliance with latest ASTM specification. Pertinent data shall be recorded and available upon request. Program shall conform with ISO 9001 and/or cover the following:

1. Typical scheduled testing and inspection of fusion equipment.
2. Uniformity of plate temperatures.
3. Random inspection of no less than one fitting from each lot

C. Field Fusion Joints: Field butt-fusions may be made by either the PE pipe supplier's Field Fusion Technician or Contractor's personnel who have been individually trained in thermal fusion by the pipe manufacturer or the manufacturer's qualified representative. A list of those personnel trained in making butt-fusion joints shall be posted in the Contractor's site trailer.

D. Individual Qualification: The Contractor shall ensure that persons making heat fusion joints have received training and are certified in the Manufacturer's recommended procedure. The Contractor shall maintain records of trained personnel, and shall certify that training was received not more than 12-months before commencing construction. As part of required fusion training, in order to verify the fusion operator skills, it is required that sample fusion joints be made for destructive testing. These tests shall be on representative size pipe, fused by the personnel in training per the ASTM F2620 fusion procedure, and successfully tested per the bend-back testing in Appendix X4 of ASTM F2620. Certification shall include training of the individual in making large diameter fusions, where bend-back testing is not applicable, where certification shall be based on data logging and visual inspection.

E. Field-Fusion Joint Quality: A log of all field-fusion joints shall be maintained with the following information:

1. Time of fusion[1]
2. Heater plate temperature[1]
3. Hydraulic cylinder pressure[1]
4. Size and SDR of pipe

5. Duration of heat cycle
6. Duration of cooling cycle
7. Interfacial pressure used & corresponding drag factors
8. Visual condition of bead roll-back
9. Comments

Notes: [1] Indicates information recorded directly onto data logging instrument by *McElroy Manufacturing Inc*., or approved substitute.

F. Referenced Specifications:

1. ASTM D3035 Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
2. ASTM D3261 Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
3. ASTM F714 Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter, per Table 7 for IPS pipe.
4. ASTM F905 Practice for Qualification of Polyethylene Saddle-Fused Joints.
5. ASTM F2206 Standard Specification for Fabricated Fittings of Butt-Fused Polyethylene (PE).
6. ASTM F2620 Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.

1.5 SUBMITTALS

A. General Information:

1. Submit information describing all dimensions and all specified physical properties of pipe and fittings.
2. Submit detailed information on dimensions of fabricated reducing Tee fittings where a reduced diameter may be included in the smaller branch piping. Submit dimensional information on all other fittings for compliance with 100-percent SDR 17 internal diameters.
3. This submittal information is to be completed prior to shipping of any materials to the site or commencement of any factory fabrications.

B. Cell Classification Properties: Submit listing of cell classification properties, ring tensile strength, and other properties called out under "Pipe Materials" specified below in Section 2. The Owner may choose to select samples for testing from pipe or fittings supplied to the job. All such material and labor prior to testing shall be delivered at the Contractor's expense. Laboratory costs for this testing shall be at the Owner's expense. Any pipe or fitting with material not meeting the minimum cell classification value will be rejected.

C. Testing: If there are any discrepancies at any time, the contractor shall submit results on tests of each factory production run of pipe (from material or pipe) for the following listed items. The cost of the above testing shall be carried by the Contractor in the base bid and tested per ASTM F714.

1. Melt Index.
2. Density.
3. Percent Carbon.
4. Dimensions.
5. Ring Tensile Strength and/or Burst Pressure.

D. Guarantee Delivered Materials: Submit a guarantee, or affidavit, or quality certification that all pipe and fittings delivered to the project will match properties of the submitted items within

industry standard tolerances. At the minimum, certification shall indicate compliance with referenced ASTM standards.

E. The Contractor shall only submit Record Drawings which have incorporated dimensions from the pipe supplier's shop drawings.

F. Q/A for Pipe: For all pipe, submit a description from the pipe manufacturer giving details of factory quality assurance (Q/A) procedures.

G. Q/A for Fittings: For all factory fabricated fittings, submit a description from the fitting fabrication shop giving details of the fabricator's quality assurance (Q/A) procedures, or submit a certificate of compliance with Q/A procedures defined by ASTM and the PPI Handbook.

H. Personnel Qualifications: Before beginning field assembly of field-fabricated fittings, submit documentation of fusion training and certification for field personnel.

1. Submit documentation, that the Field Fusion Technician, and/or Fusion Provider, and/or Contractor's field installing personnel, are qualified or certified by the pipe distributor or manufacturer of the butt-fusion equipment, and where applicable have received competent training in the proper use of the electro-fusion devices.
2. Submit list of Contractor's personnel who have received competent training in making fusions with date of training and name of specialist giving the training. Include listing of training for "standard butt-fusion" and/or "electrofusion" as applicable.

I. Coupling Fusion Device: Submit information describing electronic device used with "electro-fused couplings" including list of data automatically recorded with each coupling fusion.

J. Warranty: Submit warranty conforming at minimum to the limitations listed below.

1.6 IDENTIFICATION

A. All pipe and fittings shall be clearly identified with the manufacturer's name, nominal size, SDR rating and production date at the minimum.

B. All factory-made fusion beads shall be identified with a code number and the manufacturer shall keep records for tracking of any such fusion to its place and time of origin. Identification shall be by imprint in or adjacent to the bead.

C. All field fusions shall be imprinted with an identification number and the installer shall keep a log book recording each joint with pertinent information.

1.7 WARRANTY

A. Pipe and fitting supplier shall provide a one-year warranty coving defects in product material and workmanship. Warranty period to begin at "startup" of the life support system when operation of the piping system is turned over from the Contractor to the Owner. A successful pressure test, or pressure leak test, prior to the expiration of the warranty period shall not relive the supplier of warranty responsibility for the full warranty term.

B. Fusion Providers (or the Field Fusion Technician) shall provide a one-year warranty concerning defects in fusion joining workmanship that shall provide for remaking defective butt fusion, saddle fusion, or electrofusion joints. Warranty period to begin at "startup" of the life support system

when operation of the piping system is turned over from the Contractor to the Owner. A successful pressure test, or pressure leak test, prior to the expiration of the warranty period shall not relive the supplier of warranty responsibility for the full warranty term. The Contractor shall bare all costs associated with excavation, and repair of materials above, with warranty of buried piping.

PART 2 - PRODUCTS

2.1 PIPE MATERIALS

A. Pipe shall be manufactured in accordance with ASTM F714 Standard Specification for POLYETHYLENE (PE) PLASTIC PIPE (SDR-PR) BASED ON OUTSIDE DIAMETER per Table 7 for IPS pipe sizing.

1. Typical wall thickness for piping larger than 2-inch in diameter piping shall be **SDR 17.** The term “piping” shall mean both pipe and fittings.
2. Wall thickness for piping 2-inch and smaller in diameter shall be **SDR 11**.

B. To address the basis of design in terms of stress and long-term strain, it is the specifying Engineer's intent that the pipe be rated for 125 psi in accordance with ASTM F714. All pipe, fittings and fabrications shall be applicable pressure testing specified in the General Conditions for a 3-hour 90 psi expansion phase followed by a 1-hour 80 psi test phase.

C. Polyethylene pipe shall be rated as PE4710 by the Plastic Pipe Institute and shall conform to ASTM D3350 (latest edition) with a cell classification meeting the following criteria (which meets or exceeds PE445574C). This criteria shall be documented by the pipe manufacturer and/or the resin manufacturer.

1. Density of 0.955 gm/cc nominal, 0.947 gm/cc minimum, per ASTM D 1505.
2. Melt Flow Index of 0.15 gm/10 minute nominal, 0.2 gm/10 minute maximum, at 190 deg C / 2.16 kg load; or 9.0 gm/10 minute nominal (8.0 min. to 9.5 max.) at 190 deg C / 21.66 kg load; per ASTM D1238.
3. Flex Modulus of 135,000 psi nominal, 110,000 psi minimum, per ASTM D790.
4. Tensile Yield Strength of 3,500 psi nominal, 3,200 psi minimum per ASTM D638.
5. Environmental Stress Cracking (ESCR) of 5,000 hrs. minimum per ASTM D1693 (cond. C) or Slow Crack Growth in excess of 500 hours per PENT (F1473).
6. Long Term Hydrostatic Strength of 1,530 psi minimum per ASTM D2837 for a Hydrostatic Design Basis of 1,600 psi.
7. U-V Stabilizer shall be 2% to 3% carbon black.
8. Shore "D" hardness of 60 minimum, 65 nominal per ASTM D2240.

D. All pipe shall be supplied in straight lengths. Pipe coiled on spools is not acceptable and will be rejected.

2.2 FITTINGS

A. Fitting Construction:

1. Elbow fittings 8-*inch di*ameter and smaller shall be factory molded-type and manufactured in accordance with ASTM D3261.
2. Elbows larger than 8-inch may be molded-type or mitered fabrication**.**

3. Molded fittings 3-inch and larger shall be SDR 17 not be substituted with lower SDR fittings with reduced internal diameter.
4. Fittings 2-inch and smaller shall be SDR 11.
5. 90-degree elbow fittings in “vacuum” piping shall long-sweep radius of molded or mitered construction. If mitered construction, shall be of 5-segment minimum.

B. Mitered Fabricated-Type Elbow Fittings:

1. Thermally butt-fused mitered construction is allowable only for elbow fittings 10-inch and larger in diameter and in compliance with ASTM F2206.
2. 90-degree elbows shall be 5-segment minimum.
3. Constructed of all SDR 17 segments where 3-inch and larger.
4. Mitered elbow fittings shall be within three-degree in tolerance of the nominal bend.
5. All *internal* beads shall be trimmed flush with the I.D. of the pipe wall. *External* beads shall not be removed.

C. Mitered Fabricated-Type Tee Fittings;

1. Thermally butt-fused mitered construction is allowable only for Tee fittings with the main line segment larger than 6-inch diameter and in compliance with ASTM F2206.
2. All *internal* beads shall be trimmed flush with the I.D. of the pipe wall. *External* beads shall not be removed.
3. Standard Tee fittings with equal size main line and branch piping shall be constructed of all SDR 17 pipe segments. Main line segments shall all be from SDR 17 pipe.
4. Mitered Tee fittings shall be within three-degrees in tolerance.
5. Reducing-Tee fittings with smaller diameter branch piping shall conform to ASTM F2206.7.2 using one of the following methods:

    a. Increased wall thickness by increasing the O.D. and machining the ends for fusion with SDR 17 pipe.
    b. Increased wall thickness of only the smaller diameter branch pipe, by used of an SDR 11 segment at the Tee fusion weld, with SDR 17 dimensions at the end connection.
    c. An internal lip at the fusion of the branch pipe no less than the internal diameter of SDR 11 pipe +/- ¼” to allow for hole saw size. The lip shall be the result of boring the hole into the main segment after fusion of the smaller diameter branch pipe.

6. Full-size standard Tee fittings (i.e. 10”x10”x10”) shall have all internal beads ground smooth and equal to the SDR 17 pipe I.D.

D. Fabricated fittings shall be manufactured to withstand constructed to withstand the specified test pressure or the full-rated pressure of the SDR pipe.

1. The specified pressure test call for a 90 psi 3-hour expansion phase, followed by an 80 psi 1-hour test phase, and other requirements specified in Section 170010.
2. Fittings shall be fabricated to carry specified pressures in the "free-ends" condition without external blocking or support of backfill.

E. Internal Surface Conditions: Mitered fabricated-type fittings shall be delivered to the job site with all of the *internal* roll-back beads trimmed flush and smooth with the pipe wall—except in the case of reduced diameter branches of Tee fittings which may have diameter reduced to SDR 11 pipe I.D.

F. Side-Wall Fused Reducing Tees: All such joints shall be of products or by equipment specifically devised for making fully fused joints such as the use of electrofusion saddles.

G. Reducers: Reducers shall conform to the details of the drawings and shall be concentric, or eccentric with flat side on top or bottom, as indicated on the drawings. Where geometry of conical reducers is unclear, the Contractor shall notify the Engineer for clarification before fabrication.

H. Electro-fusion Fittings: May be substituted for thermally butt-fused pipe joints. Shall be designed for installation with electronic monitoring and meet or exceed the SDR of the adjoining pipe.

I. Non-Approved Fittings: Adjustable fittings and other fittings, which may not be fully fused, have reduced internal diameters, or pockets which may trap debris or interfere with passage of cleaning pigs, are not acceptable and will be rejected.

2.3 PIPE JOINTS

A. All pipe-to-pipe joints and pipe-to-fitting joints shall be completed by a technique that maintains the full axial strength of the original pipe. The cost of all materials and labor shall be included in the Contractor's base bid. No reduction of testing pressure is allowed for any coupling used.

B. Typical Joints: The design intent is for typical PE pipe joints to be thermally butt-fused by a factory approved technique that maintains the full axial strength of the original pipe.

C. Electro-fused Couplings: May be substituted for thermally butt-fused pipe joints that maintains the full axial strength of the original pipe. Shall be per ASTM D3261 and designed for installation with electronic monitoring and meet or exceed the SDR of the adjoining pipe.

D. Companion Flanges: Flanged ends are typically allowed only where pipe joins to piping of a differing material, at valves, where otherwise specifically shown on the drawings, or where prior approval for use of flanges is given by the Owner. Flange-to-flange connections for joining fixed-end PE piping may be used only with prior written approval of the Owner.

1. All flanges shall have a 150 lb. bolt pattern. Bolt holes shall straddle the vertical centerline (i.e., "two-holed," level).
2. All flange adapters (or molded stub ends) shall be of the same material and have the same pressure rating as the pipe.
3. Backing rings shall be sized for ANSI 125/150 lb. bolt hole configuration and shall be sufficiently rigid to avoid any visible flexing. Material shall be Type 316 stainless steel, non-metallic material, or iron covered with thick reinforced PE coating designed for saltwater service. By *Improved Piping Products* (800) 969-0962 www.ipp-inc.com; or approved substitute.
4. The use of PE “Butterfly Valve Adapter” flanges, with relief on the inside diameter for opening of valve discs, is recommended. If required for proper mating of butterfly valves, custom polyethylene spacers shall be provided. Gaskets are not required between the spacer and rubber booted butterfly valves. Faces of spacers on the valve side must be flat, and without "O" ring grooves or other undulations, in order to be compatible with installation of valves. Gaskets between the PE spacer and the PE pipe are optional and may be provided at the discretion of the Contractor.
5. Provide ribbed EPDM type rubber gaskets where flanges are used to accomplish a change in material.

E. Transition Fitting: Used for transition from PE pipe to PVC pipe where specifically called out on the Drawings where a flanged connection is not indicated on the Drawings. Limited to small pipe diameters for standard available manufactured transition fittings. All transition fittings shall be products manufactured specifically for PE to PVC pipe transitions and recommended by the manufacturer for that application.

1. Transition Union Fittings: Available in 2”x2” size. Manufactured of grey PVC and meeting ASTM D-1784 and F-1970 standards. Built with a PVC True Union coupling, with a BUNA-N rubber O-ring, for connection to 2-inch diameter HDPE pipe and a threaded PVC male end. Shall be delivered with an SDR 11 HDPE pipe stub. Rated for 100 psi minimum. *Manufactured by Lasco Fittings, Inc.* Brownsville, TN (800) 776 -2756 www.lascofittings.com; or approved substitute.
2. Transition Couplings 3-Inch through 16-Inch: Manufactured with SDR 17 PE end, Sch 40 or Sch 80 PVC end matching project specifications for PVC piping, with an external Type 316 stainless steel coupling to joint all material as a single component meeting strength requirements. The design shall not allow the external stainless steel coupling to be in contact with internal fluid. Couplings shall be approved for pressure piping by the AWWA. The product shall be manufactured to meet Hydrostatic Pressure Test standards per ASTM D2513, D1599, D1598, and F-714. Shall submit information that the manufacturer has subjected fittings matching the delivered product to hydrostatic testing with a minimum pressure of 670 psi, at a minimum 80 deg Centigrade water temperature, for a test of 170 hours minimum. Shall submit information that the manufacturer has subjected fittings matching the delivered product to a pull-out test force exceeding 4,000 lbs. force. All buried transition couplings shall be wrapped by the installing Contractor with the corrosion resistant wrapping specified in the General Provisions Section of the specifications. Manufactured by *Poly-Cam, Inc.* Anoka, MN (888) 355-5574 www.polycam.com; or approved substitute.

2.4 MISCELLANEOUS

A. Wall Flanges/Anchor Flanges: Flange rings shall be provided as indicated on the drawings, and/or as required by Section 170010, to act as water-stops and to restrain pipe. Typically anchor flanges are to be provided at all concrete wall and slab penetrations. Anchor flanges may be machined from large OD pipe stock, or attached by fillet welding or butt fusion. Machined wall anchors shall be by *ISCO Industries* or approved substitute.

B. Branched Manifolds: Where branched manifolds are factory spooled, adequate protection shall be provided to prevent excess stress on the piping. Gusseting or transportation jigs and cradles shall be provided as required to protect spooled piping before installation. Grind inner joints smooth, flush and neatly where the internal diameters join together.

C. Custom Fabrications: All fittings and custom fabrications shall be fully rated for the same internal pressure as required for the mating piping/fittings. Fabrications shall be specially machined from cut pipe, polyethylene sheet stock or molded fittings. Materials shall be joined by fully heat fusing joining methods.

D. Unacceptable Joints and Fabrications:

1. Any type of joint or method not specifically addressed in this Specification or otherwise specifically approved by the Engineer.
2. Any elbow delivered to the site more exceeding specified alignment tolerance at normal temperatures and not in direct sunlight.
3. Side-wall "socket" type joints are not allowed. (Acceptable side-wall fusions must be made by either heating elements specially constructed to follow the radius of the pipe or by provision of an electro-fusion saddle with electronic monitoring.) Use methods in compliance with ASTM F905 Practice for Qualification of Polyethylene Saddle-Fused Joints.
4. Extrusion welded joints are not acceptable for pressure applications.
5. Any material with rough-hewn edges, exhibiting saw marks, or otherwise crudely fabricated and not within process industry standards is unacceptable and will be rejected.

6. Any fitting delivered to the job site with excessive material protruding past the inner wall surface in such a manner that would disturb the flow stream will be rejected.
7. Use of buried flanges shall not be added to the project without prior written approval of the Owner.
8. Use pipe overlay straps for coupling of pipes is not allowed.

2.5 PIPE MANUFACTURERS

A. Pipe Manufacturers & Suppliers:

1. *Chevron Phillips Chemical Company LP* Plano, TX (800) 527-0662 www.cpchem.com;
2. *ISCO Industries* Louisville, KY (800) 345-4726 www.isco-pipe.com;
3. *JM Eagle* Los Angeles, CA (800) 621-4404 www.jmeagle.com;
4. *Georg Fisher Central Plastics* Shawnee, OK (800) 654-3872;
5. *WL Plastics* Fort Worth, TX (682) 831-2710 www.wlplastics.com.

2.6 MOLDED FITTING MANUFACTURERS

A. Molded Fitting Manufacturers & Suppliers:

1. *Integrity Fusion Products, Inc.* Peachtree City, GA (888) 770-6330 www.integrityfusion.com;
2. or approved substitute.

2.7 FABRICATED FITTING MANUFACTURERS

A. Fabricated Fitting Manufacturers:

1. *Plasson USA* Stafford, TX (800) 241-4175 www.plassonusa.com;
2. or approved substitute.

2.8 ELECTROFUSION FITTING MANUFACTURERS

A. Electrofusion Fitting Manufacturers & Suppliers:

1. *Georg Fisher Central Plastics* Shawnee, OK (800) 654-3872;
2. *Ipex* (Friatec Gas & Water Inc. electro fusion fittings) Pineville, NC (704) 889-2431;
3. *Integrity Fusion Products, Inc.* Peachtree City, GA (888) 770-6330 www.integrityfusion.com;
4. *Plasson USA* Stafford, TX (800) 241-4175 www.plassonusa.com;
5. *Strongbridge International Inc.* Jacksonville, FL (904) 278-7499 www.strongbridge.us;
6. or approved substitute.

2.9 FIELD FUSION TECHNICIANS

A. Field Fusion Technicians:

1. *HDPE, Inc.* Mulberry, FL (863) 607-4730 www.hdpeinc.com;
2. *High Country Fusion* Bellevue, ID (800) 780-6330 www.hcfusion.com;
3. *ISCO Industries* Louisville, KY (800)-345- 4726;

4. *Shale-Inland PVF* Lakeland, FL (863) 646-1493 or (800) 966-0617 www.shalepvfflorida.com;
5. S & S Directional Boring, Ltd. Bryan, OH (419) 630-0726;
6. Or approved substitute.

PART 3 - EXECUTION

3.1 GENERAL PIPE INSTALLATION

A. Per Section 170010.

3.2 PE PIPING INSTALLATION

A. See Section 170010 for requirements for special trenching and backfill for PE/HDPE pipe per AWWA M55. Buried PE/HDPE piping, located under hydraulic structures, may be installed with properly compacted backfill material, or CDF encasement, except in cases where CDF is specifically called for on the Drawings.

B. Pipe shall be off-loaded and handled in accordance with the pipe manufacturer's instructions and AWWA M55.

C. Pipe shall be handled and supported with the use of woven fiber pipe slings or approved equal. Care shall be taken to not cut, gouge, scratch or abrade the piping in any way. Use of hooks, chains, wire rope or device which damages the surface of the piping is strictly prohibited.

D. All thermally field-fused joints shall be made by personnel trained and/or qualified as specified above. Pipe fusion shall be performed using the pipe manufacturer's recommended procedures; including temperature of heater, fusion interface pressures and cool down times; per ASTM F2620.

E. Alignment of End Connections: Since polyethylene is a flexible material, the Contractor must make special arrangements to maintain tolerances at connection flanges, including one of the following methods:

1. *Method No. 1:* Before encasing or burying PE pipe, bolt flanged ends to above grade manifolds including in-line valves and properly align the entire assembly.
2. *Method No. 2:* Before encasing or burying PE pipe, secure ends to be connected to above-grade piping with rigid steel template and align to precisely match underground piping with above-grade piping.
3. *Method No. 3:* A Contractor selected method rendering all piping properly installed, pressure tested, connected to differing materials, and properly aligned.

F. Typically, all PE-to-PE joints for pipe smaller than 24-inch diameter, joints shall thermally butt-fused, or joined by electro-fusion couplings. ASTM F1290 and the electrofusion fitting manufacturer's recommended joining procedure shall be observed for installation of electrofusion joints.

G. Electro-fused couplings shall be removed and replaced whenever the electronic monitoring registers an abnormal fusion process regardless of pressure testing results.

H. Electro-fused fittings and joints not meeting the pressure test shall not be re-fused or attempted to be patched by fillet welding. Defective electro-fusion shall be removed and replaced.

I. Where electrofusion fittings are used in waters of a fish or shark tanks, the exposed metal electrode shall be ground to below the surface of the PE with a manually applied PE cap made over the metal electrode by field-fusion or the metal electrode shall be encased in structural concrete to a depth not less than 3-inch.

J. Field fillet-welding shall not be used on any piping for any reason except for attachment of anchor flanges.

K. Branched piping shall be specially rigged to prevent any excess stresses before and during installation.

L. The addition of any elbow or bend fittings, not specifically shown on the drawings, must be approved by the Engineer before installation.

M. Field-fused joints tying in long lengths of piping shall be done as close to operating temperature (65 deg F) as possible. Such joining shall be scheduled for early in the morning or otherwise acceptable periods during the day when the piping is cool.

N. Piping shall be restrained with an anchor flange at all penetrations through concrete slabs and walls. Where used as waterstops, the flanges shall be ringed at the pipe circumference with waterstop material per detailing shown on the drawings. Anchor flanges may be field installed.

O. Where the Contractor believes it is necessary to further restrain the piping to ensure proper dimensions are held, or as otherwise required for installation of the piping system, the Contractor may optionally encase or block portions of the polyethylene pipe in CDF, at his own expense, along with consent of the Owner. Under no circumstances shall the Contractor encase any joints prior to completion of a witnessed and approved pressure test in accordance with Section 170010.

P. All completed piping shall be hydrostatically pressure tested after installation as specified in Section 170010 and in accordance with manufacturer's recommendations—all pipe, fittings and fabrications shall be pressure tested in the field with a 3-hour 90 psi expansion phase followed by a 1-hour 80 psi test phase—including other conditions specified in Section 170010 General Conditions. When pressure testing polyethylene piping, the pressure will vary throughout the duration of the test; the pressure test shall be qualified by visual inspection for leaks.

Q. The Contractor shall take precautions for expansion and contraction of PE piping when pressurized or with changes in temperature.

1. When pressurized, the expansion must be taken into account by the Contractor where piping is free to move and otherwise specially secured where the piping is fixed at a given location.
2. Where PE piping penetrates a hydraulic wall structure (or tank wall) the concrete shall not be placed when the PE piping material is at temperature higher than 100 deg F due to direct sunlight or environmental conditions. The Contractor shall only place concrete at PE wall penetrations in the cool hours of the day or provide special shading and icing for cooling of the PE pipe at the wall penetrations.

R. Where piping is defective or damaged, the entire section shall be cut out and a new section shall be thermally butt-fused in place. Where pipe wall is gouged deeper than 10% of its wall thickness, it shall be replaced. Where physically impossible to remove the defective or damaged

section, a heat-fused repair blanket (or ”electro-fused pipe strap“) may be used to make the repair if approved in advance by the Owner.

S. Backfill in accordance with the manufacturer's recommendations, Section 170010, and as indicated on the drawings. Pipe is to be filled with water at a slight pressure (2 to 5 psi) during backfilling.

END OF SECTION 170250

SECTION 170261 - OZONE GAS PIPING

PART 1 - GENERAL

1.1 USAGE

A. The ozone gas piping is used for pressurized ozone gas and oxygen carrier gas. A combination of stainless steel tubing, or dual containment piping is specified, depending on locations indicated on the Drawings. The intent is to have the most corrosion-free system possible, where non-metallic dual containment piping can be used, while stainless steel tubing is used for practical situations.

1.2 SUMMARY

A. The General Conditions apply to this Section as fully as if repeated herein.

B. The drawings label piping with a PROCESS-MATERIAL-SIZE designation. Provide piping specified herein where designated as 316 SS on the Drawings.

C. Work includes:

1. Stainless steel ozone gas tubing at the ozone generator(s), and at the ozone injectors, where the dual containment piping system is not used.
2. Dual containment piping consisting of Teflon tubing encased in PVC electrical conduit.
3. Molded PVC junction boxes at transition between stainless steel pipe and dual containment piping.
4. Teflon tubing connection at the injectors.

1.3 SUBMITTALS

A. Submit information describing all dimensions and materials of fittings.

1.4 COORDINATION

A. Coordinate fittings with ozonation equipment and valves.

PART 2 - PRODUCTS

2.1 STAINLESS STEEL TUBING OR PIPE MATERIALS

A. Provide where dual containment system is not installed for ozone gas piping. Either welded Sch 40 piping, or tubing, as specified below.

B. Stainless Steel Tubing Option: Type 316, fully annealed, stainless steel tubing suitable for bending and flaring. No grade of tubing other than high quality, seamless hydraulic tubing manufactured of Type 316 is acceptable. Wall thicknesses per ASTM A269.

1. All tubing and fittings shall be cleaned of all grease for oxygen service.

2. Stainless Steel Tubing Fittings: Joints for connecting ozone gas tubing shall be two, ferrule-type tube fittings: Fittings suitable for the transmission of 5% ozone and 95% oxygen at 120 deg F. All pieces machined of Type 316 or Type 316L stainless steel, in either case carbon content shall be limited 0.05%. Design shall incorporate a make-up gap for go/no go gaging for calibration of installation. Each fitting shall be capable of at least 20 remakes. Seal design shall allow compensation in normal variations in tubing dimensions. Manufactured by: *Crawford Fitting Company* (Swagelok) Solon, OH; or equal.

C. Stainless Steel Pipe Option: Pipe shall be Type 316, Schedule 40, stainless steel pipe. No other grade of stainless steel is acceptable. Shall be high quality, seamless, hydraulic piping, ASTM-A312 with markings per ASTM-A530 and dimensions as shown in ANSI B 36.19. Pipe joints shall be as follows:

1. Typical pipe joints shall be socket-welded, including couplings and elbows. Socket-welded joints shall be Type 316 stainless steel socket weld pipe fittings. Welding shall be by the Tungsten Inert Gas (TIG) process. Manufactured by: Cajon Company (Swagelok), Macedonia, OH; or approved substitute.
2. Where specifically called out on the Drawings, connections to the ozone generators shall be with flexible hose as specified below.
3. Connections at valves shall be threaded with adjacent unions to facilitate removal of installed valve for maintenance.
4. Miscellaneous: Where required to connect to equipment or valves, flanged fittings shall be Schedule 80 with 150 lb. ANSI bolt pattern, Type 316 stainless steel body and hardware with Teflon or Hypalon gaskets.

2.2 TEFLON TUBING & FITTINGS

A. Install Teflon tubing in dual containment system with PVC electrical conduit as the exterior containment pipe. All flex tubing inside the PVC dual containment shall be of a continuous length from the spool and free of connecting fittings.

B. Tubing: Teflon, or PTFE, or fluorinated ethylene propylene (FEP) flexible tubing sized to work with specified fittings. Conforming to ASTM D 3296, Type II fractional inch sizes, Class D chemical tubing. Natural translucent color. “Standard” wall thickness for 5/16 inch and smaller; “Heavy” wall thickness for 3/8 inch through 7/8 inch; “Standard” wall thickness for one-inch inside diameter and larger; as follows:

NOMINAL SIZE	OUTSIDE DIAMETER	WALL THICKNESS	INSIDE DIAMETER
1/4 in	5/16 in	0.030 in	0.250 in
5/16 in	3/8 in	0.030 in	0.313 in
3/8 in	1/2 in	0.062 in	0.375 in
7/16 in	9/16 in	0.062 in	0.438 in
1/2 in	5/8 in	0.062 in	0.500 in
5/8 in	3/4 in	0.063 in	0.625 in

C. Fittings: Provide flared type fittings (compression type fittings not recommended). Body and nuts constructed of Teflon, PTFE, PVDF, PFA or FEP. Seals and/or O-rings (as applicable) of viton, silicon, or Gortex. Provide threaded end connections as required for connection to dissimilar materials.

D. Manufacturers & Suppliers:

1. *Altaflo* Hopatcong, NJ (973) 663-3303 www.altaflo.com;
2. *Furon* Anaheim, CA (714) 630-5818 www.furon.com;
3. *Harrington Industrial Plastics, Inc.* Chino, CA (909) 597-8641 or (800) 937-2527;
4. *Corrosion Products, Inc.* St. Louis, MO (800) 528-7473 www.corrosionproductsinc.com;
5. Approved substitute.

2.3 PVC CONDUIT AND JUNCTION BOXES

A. Conduit: For outer wall of dual containment piping with Teflon tubing as the inner ozone gas carrying conduit. Schedule 80 PVC (polyvinyl chloride) conduit and long-sweep fittings. Conduit to comply with NEMA Specification TC-2 and UL Standard 651. Fittings to comply with NEMA Specification TC-3 and UL Standard 514b. All fittings and couplings installed with manufacturer's approved cement.

B. Junction Box: Used for transition between stainless steel ozone gas pipe and dual containment piping. Manufactured of molded PVC to meet NEMA-4X standards with screw attached gasketed cover.

C. Manufacturers: *Carlon Lamson & Sessions* Cleveland, OH www.carlon.com; or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and support piping per Sections 170010 and 170310.

B. Install piping connections to ozone generators to allow for routine maintenance of ozone generators and reduce transmission of vibrations into the piping system. This may include "off-sets" and changes in direction of installed pipe to allow for movements required during maintenance.

C. Install specified translucent *Teflon* tubing between hard piping and ozone injector. Length as required for one single length of Teflon tubing at connection to injector. Install specified fittings as necessary to prevent kinking of tubing. At end connections, provide threaded male or female fitting for connection to stainless steel piping and the eductor/check valve.

D. Clean all piping for oxygen service and free of grease and oils.

E. Leak check all single-wall fittings and other single-wall gas pipe connections by soap-bubble testing with SNOOP Liquid Leak Detector manufactured by: Nupro Company (Swagelok), Willoughby, OH; or approved substitute. And/or check for ozone leaks with a solution of potassium iodide (2% KI) soaked on a clean white by observing a brownish-red color if ozone is present on the moist white rag.

END OF SECTION

SECTION 170267 - LSS PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Installed on all interior piping where there is a potential for the water temperature of 64 degrees Fahrenheit or less. Including the following installations:

1. EX2- LPS – SPINY LUMPSUCKER
2. EX3 – PRC – PACIFIC ROCKEY COAST
3. CRO – COLD REVERSE OSMOSIS SALTWATER SYSTEM

1.2 SUBMITTALS

A. Submit data identifying thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Submittal shall include manufacturer's recommendation for use with trace heating cable.

C. Submit typical details/drawings of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.

D. Submit typical details/drawings for attachment and covering of heat tracing inside insulation.

E. Submit color selection for PVC jacketing, where applicable.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Insulation shall be installed by skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

1.4 COORDINATION

A. Coordinate insulation with size and location of supports, hangers, and insulation shields.

B. Coordinate installation and testing of heat tracing. Where required by Code or governing authority, heating cables shall be installed by Electrical Contractor.

C. See specification Section 170666 for removable insulating jackets required at cold water heat exchangers.

PART 2 - MATERIALS

2.1 GENERAL INSULATION MATERIALS

A. This Section includes insulation for exterior life support piping. The insulating system shall have the following properties:

1. Excellent resistance to moisture.
2. Tough exterior resistant to abrasion.
3. Made with EPA registered antimicrobial protection.
4. Recommended system for heat trace cable on the pipe.
5. Thermal R value shall meet or exceed of 4.0 hr/sq-ft/ deg F/Btu at 75 deg F (Thermal Conductivity shall be less than 0.245 Btu in/hr sq-ft deg F at 75 deg F.)
6. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less for thickness up to 1-1/2 inches as tested by ASTM E 84.

2.2 INSULATION MATERIALS

A. Flexible Closed-cell Elastomeric: Closed-cell rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Selected product shall have high temperature limit of at least 200 deg. F for compatibility with heat trace cable.
2. Provide external moisture barrier system as, and if, recommended by manufacture of insulation. Water Absorption rating of closed-cell elastomeric material shall be a maximum of 0.2% by volume
3. Manufacturers:

    a. “Aerocel EPDM” by *Aeroflex USA Inc.* www.aeroflexusa.com
    b. “Armaflex” *Armacell LLC* www.armacell.com

A. Substitutes: Substitute insulation materials shall be subject to review by the specifying engineer and shall not include water absorbing materials such as mineral wool, fiberglass, or calcium silicate.

2.3 JACKETING

A. When the insulating product requires a jacketing, include a complete 30 mil PVC exterior jacket. Exterior jacket shall be provided in owner-approved color selections or painted per Section 170010.

B. High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354 C; 30 mil thickness; roll stock ready for shop or field cutting and forming.

C. Manufacturers: Johns Manville; P.I.C. Plastics, Inc.; Proto PVC Corporation; or Speedline Corporation.

PART 3 - INSTALLATION

3.1 GENERAL

A. All piping assemblies shall be pressure tested and leak tested before insulation is installed.

B. Refer to the manufacturer's installation instructions and design guide for proper installation and layout methods. Information in the manufacture's Application Manual is much more extensive than the specified notes and shall be adhered to by the installing Contractor.

C. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application. Verify that surfaces to be insulated are clean and dry and have been tested and are free of defects.

D. Where required, install and test heating cable system prior to insulation. Where necessary, install secondary high-temp insulation to protect insulation with a limited high temperature rating. Where heating cables are to be installed, secure heating cables with fiberglass or foil tape beneath insulation. It is recommended to increase the insulating diameter of closed-cell elastomeric tubes where installed over heat tracing cables.

E. Install insulation with smooth, straight, and even surfaces; free of voids throughout the length of equipment, piping including fittings, valves, and specialties.

F. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive and tape as recommended by insulation material manufacturer.

G. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarding integrity, unless otherwise indicated. Arrange insulation to permit access to packing and valve actuator servicing and to allow valve operation without disturbing insulation. Insulate valves using preformed fitting insulation or sectional pipe insulation. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Install closed-cell elastomeric insulation up to valve actuation spindles as illustrated in insulation manufacturer's Application Manual.

H. Insulate pipe elbows using preformed fitting insulation, including field preforming methods illustrated in insulation manufacturer's Application Manual. Each piece shall be butted tightly against adjoining piece.

I. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

J. Install removable insulation covers at locations indicated where routine access is required

3.2 JACKETING

A. Install jackets over insulation on piping where moisture and abrasion protection is required.

1. Install PVC jacketing over insulation within 6-foot of finished floor.
2. Where elastomeric insulation is greater than 6-foot above finished floor, installation of jacketing is not required.

B. Where required, install jacketing as recommended by the manufacturer.

1. Completely encapsulate insulation with coating, leaving no exposed insulation. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket.
3. Overlap jacket longitudinal seams at least 1-1/2 inches.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
5. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
6. Finish exterior surfaces with acrylic latex coating.
7. Where jacketing is terminated, at indoor piping 6-foot AFF, seal the edge of the jacketing to the closed-cell elastomeric insulation with a sealant or tape as recommend by the manufacture of the closed-cell insulation.

3.3 CLEAN UP

A. Leave all areas free of adhesives, paint or other debris. Use *Goof Off*, acetone or MEK to remove adhesive from hard surfaces — do not use such solvents on elastomeric insulation or other materials which may have original new surfaces damaged by strong solvents

END OF SECTION

SECTION 170270 - FLEXIBLE MOLDED-RUBBER COUPLINGS

PART 1 - GENERAL

1.1 SUMMARY

A. The General Conditions shall apply to this Section as fully as if repeated herein.

B. Provide flexible couplings (also known as rubber expansion joints) where indicated on the drawings. Locations may be shown on the Piping and Instrumentation Diagrams, or in plan, section, elevation, or detail. Locations may include pump connections, where required for maintenance of valves, and other specific locations.

C. Types at Locations:

1. Provide “twin sphere” where indicated on P&IDs at pump suctions.
2. Provide “single sphere” in valve pits to assist with ease of valve maintenance.

D. Both flex couplings, and spacer flange(s) with drilled holes for ANSI 125/150 bolt pattern, shall be supplied by the manufacturer.

1.2 SUBMITTAL

A. Submit description of couplings and identify materials selected for this application. Identify chemical resistance and temperature range for compatibility of selected materials. Submittal shall include shop drawings for reducing style couplings where not shown as a standard catalog product.

1.3 MAINTENANCE AND OPERAATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010.

1.4 COORDINATION

A. Coordinate the dimensions, detailing and strength requirements of mating flanges, valves and other connecting materials.

PART 2 - PRODUCTS

2.1 GENERAL CONFIGURATIONS AND MATERIALS

A. At Pump Suctions: Molded-rubber covered, “Double-Arch” (a.k.a. "Twin Sphere") or “Wide Arch” type design, multi-layered cord fabric design suitable for working pressures ranging from -10 psi to +20 psi on continuous basis. Constructed with a full-face rubber sealing surface. Axial restraining control rods are not desirable and not required. 10-inch size and greater shall allow for minimum axial compression of 1.75-inch and axial extension of 1-inch. 6-inch size and greater shall allow for transverse minimum transverse deflection of 0.875-inch.

B. At Valve Vault Locations: Provide flex couplings to allow for removal and replacement of valves at fixed piping locations. Molded-rubber covered, single-arch (or "Single Sphere") type design, multi-layered cord fabric design suitable for working pressure for the operating pressure but not less than 30-psi. Constructed with a full-face rubber sealing surface.

C. Miscellaneous Locations: Submit appropriate flex connector for review.

D. Reducing Requirement: Where piping connections change in size, provide "reducing" style flex connectors.

E. Metal flanges, backing rings, other flange plates, and tension rings between spheres shall be Type 304 or Type 316 stainless steel or hot-dipped galvanized carbon steel. Backing rings shall be solid one-piece construction or of an interlocking design that prevents “hinging” of the backing ring when mounted with a wafer type valve.

F. Spacer Flange(s): Supply each flex coupling with at least one spacer flange constructed for mating of the flex coupling where a flat surface is not otherwise provided. In the case of reducer couplings, the spacer shall be of the larger diameter. Flange adapter plates shall match ID/OD of coupling and be constructed of thick PVC or Type 316L stainless steel.

G. Liner Materials:

1. General: Interior lining shall be suitable for use with chlorinated and ozonated saltwater or seawater, and animal waste products.
2. At pump suctions: Interior lining shall be suitable for use with a mild oxidizing solution, such as EPDM rubber.
3. If installed downstream of ozone contactor or at the Deaeration Tower: Interior lining shall be suitable for use with an oxidizing solution and constructed of Viton rubber or silicone lined.
4. Where resistance to heat is required: Acceptable materials include hydrogen-peroxide-cured EPDM with Kevlar reinforcement, rated for 250 deg F.

H. Face Detailing: Faces of the coupling's flanges must be compatible for proper mating with opposing pipe and equipment flanges.

I. Manufacturer: The specified product with “2-Arch Expansion Joint with Solid Back Up Ring” and must be ***Special Ordered*** (i.e. double-arch reducing styles) to meet the above requirements.

1. *General Rubber* Pittsburg, PA (800) 233-6294 www.general-rubber.com;
2. *Mason Industries Inc.* Anaheim, CA (714) 535-2727 www.mason-ind.com;
3. *Proco Products, Inc.* Stockton, CA (800) 344-3246 www.procoproducts.com;
4. *Red Valve Company Inc.* (Redflex) Carnegie, PA (412) 279-0044 www.plantfloor.com;
5. *RM-Holz Inc.* (InterTech Group) Lodi, CA (209) 368-7171;
6. *Unaflex* Pompano Beach, FL (954) 943-5002 www.unaflex;
7. or approved substitute.

PART 3 - EXECUTION (See also 170010)

3.1 INSTALLATION

A. At pumps:

1. Fasten couplings directly to the pump flanges with hex-head bolts per Section 170316.
2. Do not use flex connectors to correct for gross misalignment of piping. Without a fixed condition/bolting, the piping shall not be more than 5-degrees or 0.5-inch out of alignment at the connection to the flex connector.

B. When butterfly valves or check valves are adjacent to the flexible coupling, use of a solid spacer flange is required to assure a positive sealing surface for the flex coupling.

C. Provide secure supporting of piping as required to reduce unacceptable displacement or movement.

END OF SECTION

SECTION 170280 - MECHANICAL PIPE SEALS

PART 1 - GENERAL (Also see Section 170010)

1.1 REQUIREMENTS

A. Locations:

1. Use for “repair” situations where new pipes requiring a water-stop seal penetrate existing pool wall. Not intended for use as water-stops for typical planned construction with new cast-in-place concrete wall construction.
2. May be used as pipe centering device in non-hydraulic walls where pipe is double sleeved (a.k.a. casing sleeves).
3. May be used for planned water-stops in new wall construction only after Owner’s approval of a substitution request where proposed to save on the cost of concrete form penetrations. Where a substitution request is approved, the wall insert shall be oversized PVC pipe sleeve with an outer perimeter cast-in-place water-stop flange.

1.2 COORDINATION

A. Sizing: Contractor shall ascertain size required for mechanical pipe sealing device based on actual outside diameter of pipe and actual diameter of core hole in concrete. Non-standard diameter seals may be necessary, especially in the case where fiberglass pipe is used.

B. Other Trades: Coordinate core drilling of concrete with structural requirements.

1.3 SUBMITTALS

A. Submit information describing all dimensions, materials physical of equipment.

1.4 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010.

PART 2 - PRODUCTS

2.1 MECHANICAL SEAL

A. Description: Modular mechanical type, consisting of interlocking, synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening. Tightening of thru-bolts shall provide a completely watertight seal between the pipe and wall opening. Seal shall be rated for 40 ft. hydrostatic pressure when properly installed.

B. Materials: Interlocking links made of EPDM rubber. Pressure plates made of composite plastic material. Tap bolts and nuts shall be of Type 316 stainless steel.

C. Manufacturer:

1. *Special Ordered* "Link-Seal" with Type 316 stainless steel hardware by *GPT Industries,* Houston, TX (800) 423-2410 www.gptindustries.com;
2. *Flexicraft Industries* Chicago, IL (800) 533-1024;
3. or approved substitute.

PART 3 - EXECUTION (See also 170010)

3.1 INSTALLATION

A. Before core drilling, determine approximate location of reinforcement steel, with non-destructive electronic equipment (*Zircon* “Metallicanner” or similar equipment), and slightly adjust exact location of pipe penetration accordingly to minimize damage to reinforcing steel.

B. Where steel reinforcement has been cut or exposed, coat the exposed steel with a 20-mil thickness of “Armatec 110 EpoCem” by *Sika*, or equal corrosion protection coating.

C. Install in accordance with Manufacturer's instructions and finish-out as detailed on the drawings.

END OF SECTION

SECTION 170286 - QUICK DISCONNECT FITTINGS & VACUUM HOSE

PART 1 - GENERAL (See 170010)

1.1 USAGE

A. Common quick disconnect fittings are used with saltwater situations.

1.2 SUMMARY

A. The General Conditions shall apply to this Section as fully as if repeated herein.

B. Provide where indicated on the drawings. For situations such as vacuum hose connections, provide a full compliment of both male and female fittings. For each permanently installed quick disconnect, provide a dust cap or plug as the case may require. Fittings on “loose” pipe or hose need not be supplied with dust cap or plug.

1.3 COORDINATION

A. Provide fitting style to match pipe, hose or type of end connection required.

B. Where mating to existing fittings, verify and assure proper fit of new fittings.

C. Coordinate installation of male and female ends for the situation at hand.

1.4 SUBMITTALS

A. General Information: Submit information describing all dimensions, materials physical of equipment.

B. Submit a guarantees’ and/or warranty. Cam handles shall be warranted by the manufacturer and addressed in the submittal.

PART 2 - PRODUCTS

2.1 NON-METALLIC QUICK DISCONNECT FITTINGS

A. Body of glass filled polypropylene or PVC. Manufactured to MIL-C-27487 dimensions for standard cam couplers.

B. Provide male and female fittings as indicated on the drawings.

C. Manufacturers/suppliers:

1. ‘’Cam Lever Couplings” by *Banjo* www.banjocorp.com , supplied by *Harrington Plastics, Inc.*;

2. *PT Coupling* www.ptcoupling.com ;
3. or approved substitute.

2.2 VACUUM HOSE AND CLEANING HEAD

A. Hoses: Provide no less than two reinforced flexible vacuum hoses, 2-inch diameter, each 50-foot length.

B. Vacuum Head: Plastic end fitting with tapered end manufactured for cleaning hard surfaces.

C. Supplier: Local swimming pool supply store.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install where indicated on the Drawings and per manufacturer's instructions.

B. Recommend installation of threaded fittings using both Teflon tape and Teflon pipe dope.

C. Deliver vacuum hose and vacuum devices to the Owner.

END OF SECTION

SECTION 170288 - EDUCTOR INJECTORS

PART 1 - GENERAL (See also 170010)

1.1 USAGE

A. For injection of ozone gas.

1.2 SUBMITTAL

A. Submit manufacture’s product information.

1.3 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010.

PART 2 - PRODUCTS

2.1 EDUCTOR INJECTORS

A. Size & Capacity: Provide injectors meeting requirements given on the drawings.

B. Materials: Body of black *Kynar* plastic.

C. Check Valve: Equip with manufacturer provided check valve on gas inlet.

D. Manufacturer:

1. *Mazzei Injector Corporation* Bakersfield, CA (805) 845-2253;
2. no substitutions.

PART 3 - EXECUTION (See 170010)

3.1 INSTALLATION

A. Minimize downstream fittings and install as close to contactor or fractionator as possible.

B. Arrange piping and/or provide flanges or unions to allow complete removal of injectors for servicing.

C. Recommend installing with use of both *Teflon* tape and *Teflon* pipe thread paste to prevent leaking at the threaded fittings.

1 END OF SECTION

SECTION 170310 - PIPE SUPPORTS

PART 1 - GENERAL

1.1 USAGE

A. Materials shall be selected based upon the location of supports and environment to which is will be exposed. The type of piping or the fluid/gas contained within is not a criterium for selection of support material.

B. As called for below: “Floor Zone” shall be less than 8-ft from the finished floor. “Ceiling Zone” shall be 8-ft and greater from the finished floor.

1.2 SUMMARY

A. The General Conditions shall apply to this Section as fully as if repeated herein.

B. Provide pipe supports and bracing where indicated on the drawings and as specified herein. Not all pipe supports are shown specifically on the drawings. Pipe supports shall also be provided where necessary to limit loads on equipment. Contractor shall refer to the pipe support guidelines, published or adopted by the pipe manufacturer, for spacing of supports. The Contractor shall evaluate each pipe configuration and span in order to determine the required support necessary.

C. Where pipe supports are not shown but are required to avoid excessive pipe deflections, provide in accordance with the pipe Manufacturer's recommendations. Pipe supports shall be similar in construction to those detailed on the drawings for similar applications. At no time shall any visible deflection in any piping be acceptable.

D. Pipe Bracing shall be provided where necessary for above support or as indicated on the drawings. Pipe bracing shall be made of the same material as supports.

1.3 COORDINATION

A. Coordinate supports with mechanical, plumbing and other trades. In common areas and parallel runs, provide similar supports using the higher grade of corrosion resistant material typically as specified in this Section.

1.4 SUBMITTAL

A. Submit manufacturer’s product information.

PART 2 - PRODUCTS

2.1 GENERAL CONSTRUCTION & MATERIALS

A. All supports shall be as detailed on the drawings and as specified herein or as supplied by support Manufacturer as per Engineer approved submittal details.

B. “All-Thread” and other threaded rod, shall conform to materials requirements for “fasteners” in Section 170316.

C. Material Locations:

1. Water Zone Locations: All submerged supports and supports over open water shall be non-metallic with Type 316 SS fasteners. Ferrous metal not allowed.
2. Floor Zone Locations: Non-metallic, aluminum with epoxy isolation coating, 300 Series SS structural components. Type 316 SS fasteners. Ferrous metal not allowed less than 8-Ft above the floor level.
3. Ceiling Zone Locations: Non-metallic, aluminum with epoxy isolation coating, 300 Series SS structural components, hot dip galvanized carbon steel, or dichromate plated manufactured supports. Type 316 SS fasteners. Plated carbon steel only allowed where 8-Ft or greater above the finished floor.

2.2 TYPES OF SUPPORTS

A. Custom Metallic Pipe Supports: Provide where custom fabrications are detailed on the drawings. Shall be manufactured of 300 Series stainless steel, Type 6061 T-6 aluminum or of carbon steel with hot dipped galvanized plating. Only stainless steel or aluminum construction shall be used for metal supports less than 8-ft above finished floor.

B. Floor Mounted Pipe Stands: Fabricated, floor mounted pipe supports shall be manufactured of fiberglass, stainless steel, or PVC pipe sections and fittings, with the following provisions:

1. Fiberglass supports shall be designed against a minimum 9:1 design stress ratio and finished with a corrosion resistant gloss coat.
2. Aluminum shall be Type 6061 T-6 and provided with the epoxy coating where mounting on concrete or masonry surfaces.
3. PVC pipe sections and fittings may be used for supports where lightly loaded. Floor stands shall consist of Schedule 80 PVC pipe sections with solvent-welded saddles top and flanged fittings at the bottom, anchored to the floor with no less than four bolts, use full size bolts for 150 lb. drilling pattern. Face and backing ring of flange shall be one piece construction (not Vanstone type). “Wedge Tee-Fittings” to fit supports onto pipe runs may be purchased from *Flo Control, Inc*., Burbank, CA.
4. Stainless steel pipe stands shall be constructed of 300 Series stainless steel.

C. Pipe Racks: Pipe hangers, wall mounted racks, trapeze type and other "standard" hangers shall comply with “Floor Zone” and “Ceiling Zone” material requirements described above. Above the Floor Zone, pre-fabricated pipe racks constructed of dichromate plated steel (A.K.A. “Unistrut”) are acceptable, along with other specified materials.

D. Pipe Hangers: Provide manufactured tear-drop or U-strap with spreader bar pipe hangers. FRP pipe hangers shall be of hand-wrapped fiberglass or of plastic composite material. Otherwise, pipe hangers shall be constructed of specified materials acceptable for the installed location.

E. Pipe Clamps:

1. FRP pipe clamps shall be heavy duty model designed for carrying water in pipes (example: clamps for 6 inch diameter pipe shall be rated for no less than a 175# load) and secured with Type 316 stainless steel bolts. Where installed in highly oxidized environments (such as ozone), clamps shall be of *vinyl ester* resin construction. Adjustable pipe straps and/or clamps with non-metallic bolts are not allowed unless specifically called out on the drawing at special situations.
2. Metal pipe clamps shall be constructed of specified materials depending on the installed location.

F. FRP Struts and Structural Shapes: Struts, mounting brackets, channels, structural box sections, etc., shall be of the pultruded method of construction.

1. Primary structural components of pultruded premium grade resin meeting E-84 ASTM Class 1 Flame Rating and self-extinguishing requirements of ASTM D-635. Resin material shall have a maximum glass content of 50% and utilize a synthetic surfacing veil for maximum chemical and ultraviolet protection.
2. Use *vinyl ester* resin for "ozone" applications, such as *Hetron* by *Ashland Chemical* or approved substitute by *Dow*. The particular resin product number used shall be the commodity specifically recommended by the resin manufacture for the actual ozone related application.
3. FRP threaded rod shall be made from *vinyl ester* resin.
4. Struts and structural shapes may be either polyester or *vinyl ester* resins for general applications.
5. Cut edges shall have sharp edges ground smooth and sealed with a compatible resin or epoxy sealer.

2.3 CONNECTIONS & FASTENERS

A. FRP Connections: Connections of fiberglass structures shall be only of non-metallic FRP nuts and bolts and/or adhesives, or Type 316 stainless steel fasteners. Anchor bolts and assembly fasteners shall be per Section 170316. FRP U-bolts shall be manufactured by: *Steelfree Inc.* Redmond, WA; or approved substitute.

B. Combination Joints: Where combination adhesive and mechanical joints are shown, the surfaces must be carefully prepared in strict accordance with the Manufacturer's recommendations. The joints shall be cured for not less than 48 hours prior to the application of any loads.

C. FRP Adhesives: The following epoxy adhesives may be used; Shell 828 Epoxy Resin; or Dow D.E.R. 331 Epoxy Resin; or MMFG Epoxy Adhesive; or equal.

2.4 FINISH

A. Epoxy Coating/Isolation: Provide protective coating over surfaces of aluminum supports that bear against concrete, stainless steel, or as coatings are otherwise called out on the drawings. Use high-solids, two component epoxy applied in not less than two coats to a total dry film thickness of 12 mils minimum. Manufacturer: *Soc-Co Plastic Coating Company* (Keysite 740) Cucamonga, CA; *Carboline* Carbothane 134 VOC; or approved substitute coating/isolation system.

B. Galvanized Plating: Provide over all custom fabricated carbon steel supports and all floor stands made from carbon steel stock. Hot dip galvanize after fabrication. (Only allowed above the Floor Zone and not above saltwater.)

C. Dichromate Plating: Stock metal strut and channel shapes with factory applied electro-chromate finish. The finish shall be dichromate over zinc by "Superstrut" Metal Framing Division, *Midland-Ross Corporation* Goshen, IN (219) 533-0335; or approved substitute. All field cut ends shall be finished with a cold galvanizing corrosion resistant coating. (Only allowed above the Floor Zone and not above saltwater.)

2.5 MANUFACTURERS

A. Non-metallic/FRP Manufacturers and Suppliers:

1. *Aickin Engineering Inc.* [pipe clamps & general shapes] Seattle, WA;
2. *Champion Strut,* Spring, TX (281) 655-8900 www.championfiberglass.com;
3. *Creative Pultrusions Inc*. Alum Bank, PA (814) 839-4186;
4. *Dura Plastics* [PVC pipe clips] Beaumont, CA (714) 845-3161;
5. *FRP Supply Company* [pipe clamps & general shapes] Burbank, CA;
6. *IMCO Reinforced Plastics, Inc.* [pipe clamps & general shapes] Moorestown, NJ (609) 235-7254;
7. *Lee Composites, Inc.* Spring, TX (888) 389-4415 www.leecomposites.com [hangers, pipe clamps & general shapes];
8. *Plasti-Fab Inc.* [hangers & general shapes] Tualatin, OR (503) 692-5460;
9. *Pupco,* Charlotte, NC (704) 333-5776 www.pupco.com [Type 316 SS, strut and hangers];
10. *Seasafe Inc*. Lafayette, LA (318) 837-9993;
11. *Steelfree Inc*. Redmond, WA (206) 869-5500;
12. *Strongwell* Rancho Cucamonga, CA (909) 941-1875 www.strongwell.com;
13. *StrutTech* (Entrum Industries Inc.) Redmond, WA (800) 848-8708 [pipe clamps & general shapes];
14. *Western Piping & Engineering Company* San Francisco, CA (415) 822-6464 [hangers & general shapes].

PART 3 - EXECUTION (See also Section 170010)

3.1 MOUNTING

A. Refer to the pipe manufacturers guidelines for pipe span lengths.

B. Adhere to Water, Floor, and Ceiling Zone limitations for installation of various materials.

C. Use only fasteners manufactured of Type 316 stainless steel, as specified in Section 170316.

D. Touch up galvanized components using one of the three methods specified in ASTM A 780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

END OF SECTION

SECTION 170316 - FASTENERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section covers fasteners and anchor bolts used in conjunction with the life support system. This includes, but is not limited to, fastening and anchorage of valves, pumps, handrails, ladders, structural supports, pipe supports and all other equipment. The General Conditions apply to this Section as fully as if repeated herein.

1.2 SUPPLIERS

A. Contractor is ultimately responsible for ensuring all equipment in his scope is provided with fasteners meeting these Specifications.

B. Where connecting fasteners are provided by supplier of FRP supports, the fasteners used in the assembly of the packaged components may be or either FRP or Type 316 stainless steel.

C. Fasteners supplied integral with Owner Furnished equipment are excluded from the Contractors direct responsibility. However, the Contractor shall supply all necessary fasteners for installation of equipment in accordance with this Specification.

1.3 SUBMITTALS

A. Submit manufacturer’s information describing the products.

1.4 COORDINATION

A. Contractor installing the life support equipment shall refer the Structural Engineer’s equipment anchoring requirement, where available.

PART 2 - PRODUCTS

2.1 MATERIAL REQUIREMENT

A. Typical Fasteners: Where Type 316 stainless steel is called for, designation shall be in conformance with ASTM specification A193/A194, Class 2, Class 2B, Class 2C, or Class 1. Type 317 SS may be substituted where Type 316 is not available. Alloying of Type 316/317 SS shall be as follows: 16% to 20% Cr, 10% to 15% Ni, 2% to 4% Mo, and no more than 0.08% Carbon.

B. Identification of all “Type 316" metal bolts per ASTM A193 (part 18. Product Marking) or with correct AISC designation stamped on head.

C. Non-metallic fasteners shall be of materials specifically formulated and manufactured for threaded connections. FRP material shall be *vinyl ester* resin with U.V. inhibitors or approved substitute. Non-reinforced PVC is *not* allowed.

1. Studs: Pultruded, machined fiberglass reinforced *vinyl ester*;
2. Bolts: "*Fibrebolt*" by: *Strongwell* www.strongwell.com;
3. Washers: FRP, resistant to strong oxidation environments.

D. Wall Anchors:

1. Option 1: Threaded plastic (non-metallic) inserts, installed in C-I-P concrete behind wall forms, where the product provides required tension loads. By *Meadow Burke*, *Bowco Industries*, or approved substitute.
2. Option 2: Drilled and epoxy anchored Type 316 stainless steel all-thread.

E. All-Thread: Where “all-thread” and other threaded rod is specified in Section 170310, and indicated elsewhere, all-thread shall conform the materials requirements as “fasteners” in this Section.

2.2 GENERAL FASTENER LOCATIONS

A. Typically, all valve flange bolts, pipe support fasteners and miscellaneous fasteners shall be Type 316 stainless steel bolts, nuts and washers; unless other material is specifically called out.

B. Where specifically called for, provide Fiber-Reinforced Plastic (FRP) fasteners.

C. Where fasteners are used to secure components in Seismic Design Categories C or greater, anchors shall be of the type recommended for use in seismic applications.

D. At all locations where "bolt" is called for, a "hex-head bolt" shall be provided. Hex-head bolts shall not be substituted with "all-thread" without prior written consent of the Owner. Hex-head bolts shall be provided for installation of all valves, companion flanges, flex connectors and other similar locations.

2.3 ANCHOR STUDS & THREADED INSERTS

A. Minimum pullout strengths shall meet or exceed those published in the *International Building Code* (IBC), *ASCE*, or other authorized publications.

B. Anchor bolts, studs, washers and nuts shall be Type 316 stainless steel of the following design:

1. Cast-in-place; "J" bolts type.
2. Drilled; set in with an epoxy/aggregate filler.
3. Drilled; expansion type (wedge anchors).
4. Dual Drilled: non-expansive swiss lock type.

C. Only where specifically called for, provide *Fiber-Reinforced Plastic* (FRP) anchor studs. Minimum size of 3/4 inch diameter, unless otherwise specifically called for on the drawings.

D. Threaded Inserts: Use behind C-I-P wall and slab forms for threading of anchors. 0.375-inch size with minimum tension capacity of 600 lbs. 0.5-inch size with minimum tension capacity of

2,880 lbs. 0.75-inch size with minimum tension capacity of 3,400 lbs. Model PC-11 manufactured by Meadow Burke; or approved substitute.

2.4 MANUFACTURERS

A. Cap Screws (Standard Hex-Head Bolts), Nuts and "J" bolts: Non-proprietary manufacturer of Type 316 stainless steel hardware.

B. Expansion Type Anchor Studs: Type 316 stainless steel by *Hilti Inc.* Tulsa, OK (800) 879-8000; or approved substitute.

C. Anchor Bolts: Type "VD-1" bolt with epoxy/aggregate secured threads by *Structural Anchoring Systems* Worcester, MA (508) 853-3991; or approved substitute.

D. Swiss Lock Anchors: Type "SR" system by *Structural Anchoring Systems* Worcester, MA (508) 853-3991; or approved substitute.

E. Epoxy Aggregate Capsules:

1. "Parabond" by: *Molly Fastener Group* Temple, PA;
2. Type "VD" Anchor Capsules by: *Structural Anchoring Systems* Worcester, MA (508) 853-3991;
3. or approved substitute.

F. FRP Studs and Nuts: *Strongwell* Bristol, VA (540) 645-8000 www.strongwell.com; or approved substitute.

PART 3 - EXECUTION (See Section 170010)

3.1 INSTALLATION

A. As modified by seismic zone requirements given above, only cast-in-place with concrete, or drilled-into-concrete with epoxy/aggregate or expansion type anchoring systems shall be used; powder driven fasteners are not allowed. All anchors shall be perpendicular to surfaces.

1. Cast-in-place fasteners shall have positive anchoring heads or tabs resistant to pulling out of concrete.
2. Epoxy/Aggregate Anchoring System: Drill and fix threaded studs in place with glass capsulated epoxy/aggregate mixture per Manufacturer's recommendations.
3. Expansion type shall be installed per Manufacturer’s recommendations and held fast in concrete without side-to-side movement possible. Expansion type anchors are limited to C-I-P concrete slabs and not to be installed in wall surfaces.

B. Apply *ANTI-SEIZE COMPOUND TO ALL STAINLESS-STEEL* nuts and bolts to prevent metal transfer of similar metals.

C. Install FRP fasteners in strict accordance with Manufacturer’s recommendations, including the following:

1. A torque wrench *must* be used.
2. Bearing surfaces must be parallel to the fastener’s surface.

3. Lubricate according to Manufacturer's recommendations.
4. Spray with a light coat of polyurethane after installation.

END OF SECTION

SECTION 170360 - BASKET STRAINERS

PART 1 - GENERAL (See Section 170010)

1.1 USAGE

A. The basket strainers are used to remove gross solids such as rocks, sticks, and hay from water returning from aquatic animal exhibits. All strainers shall be manufactured for saltwater use.

1.2 SUMMARY

A. Provide where indicated on the drawings and as specified herein. The General Conditions shall apply to this Section as if fully repeated herein.

B. Provide one spare strainer basket for each unit size installed on project.

1.3 SUBMITTALS

A. Supplier to submit product data on basket strainers, all materials of construction, and dimensional drawings. Submit manufacturer's recommended maximum water pressure for standard models, and for high pressure applications, submit information covering the installed water pressure.

1.4 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010.

PART 2 - PRODUCTS

2.1 CLEAR PLASTIC Y-STRAINERS

A. Location: Where indicated on drawings for 0.5-inch to 2-inch line sizes.

B. General: Y-type strainers manufactured of clear PVC with non-metallic perforated screen. Installed with flanged or true-union connections.

C. Shall be listed by the manufacture for a water pressure greater than 100 psi at 80 deg F. Basket strainer shall be capable of operation under full negative vacuum pressure.

D. Manufacturer:

1. *ASAHI/AMERICA* Malden, MA (781) 321-5409 www.asahi-america.com;
2. *Hayward Flow Control* Clemmons, NC (888) 429-4635 www.haywardflowcontrol.com;

3. *Spears Manufacturing Company* Sylmar, CA (818) 364-1611 www.spearsmfg.com;
4. or approved substitute.

2.2 CLEAR CAP BASKET STRAINERS

A. Location: Where indicated on drawings for 3-inch through 12-inch line sizes.

B. General Description: Vertical style basket strainer with FRP over-wrapped PVC body, clear acrylic top cover. Shall have "oversized" body diameter and meet end-to-end laying length indicated on the scale drawings. End connections shall be Vanstone type flanges. Minimum dimensions shall be as follows:

1. Strainers with 3-inch nozzles shall have shall have minimum Basket to Pipe cross section ratio of 29:1 or 200 square inch basket area or greater.
2. Strainers with 4-inch nozzles shall have shall have minimum Basket to Pipe cross section ratio of 28:1 or 350 square inch basket area or greater.
3. Strainers with 6-inch nozzles shall have shall have minimum Basket to Pipe cross section ratio of 19:1 or 424 square inch basket area or greater.
4. Strainers with 8-inch nozzles shall have shall have minimum Basket to Pipe cross section ratio of 15:1 or 754 square inch basket area or greater.
5. Strainers with 10-inch nozzles shall have shall have minimum Basket to Pipe cross section ratio of 13:1 or 1,020 square inch basket area or greater.
6. Strainers with 12-inch nozzles shall have shall have minimum Basket to Pipe cross section ratio of 12:1 or 1,350 square inch basket area or greater.

C. Cover Closure: Top release shall be an easy-to-access design, with twist and release hasps or "Tee" handles of Type 316 stainless steel.

D. Basket: Type 316 stainless steel strainer basket of welded or brazed construction. Manufacturer's standard (larger if option exists) perforations.

E. Pressure Rating: Shall withstand full vacuum through the maximum water pressure for specific application. Standard models shall be listed by the manufacturer of a maximum positive pressure not less than 50 psi.

F. Accessories:

1. Top vent.
2. Pressure taps at inlet and outlet ports.
3. Spare basket(s). Deliver one (1) spare basket per basket size on the project.

G. Manufacturer: Not all of the following manufactures may be able to meet the specified requirements with a standard product in which case the selected manufacturer must provide custom manufactured basket strainers meeting the specified requirements.

1. *FLUIDTROL Process Technologies Inc.* (ESW Series), Huntsville, AL (205) 444-9355 www.fluidtrol.com;
2. *Mer-Made Filter, Inc.,* Denmark, SC (803) 793-4265 www.mermade.com;
3. or approved substitute.

PART 3 - EXECUTION (See Section 170010)

3.1 INSTALLATION

A. Do not install ahead of pumps already equipped with integral basket strainers.

B. Construct piping layout to provide proper off-sets for connection to strainer body.

C. Coordinate with height required for concrete housekeeping pad for pump.

D. Deliver spare strainer baskets to Owner at end of construction (one for each size installed).

75 END OF SECTION

SECTION 170410 - PRESSURE GAUGES

PART 1 - GENERAL

1.1 USAGE

A. The pressure gauges are used in liquid and gas piping systems where indicated on the P&ID drawings.

1.2 SUMMARY

A. Provide where indicated on the drawings, including all "Diagrams" and "Standard Details, and as specified herein. The General Conditions shall apply to this Section as fully as if repeated herein.

B. Installation is required at all pump suction, filter influent (pump discharge), filter effluent, heat exchanger influent, heat exchanger effluent, and eductor influent lines (regardless of indication on Drawings).

1. Provide positive pressure gauges where “PG” is indicated on the P&IDs.
2. Provide compound negative-positive pressure gauge where “CG” on the P&IDs.

1.3 COORDINATION

A. Coordinate maximum pressure rating for each application. The lowest pressure gauge shall be selected without the maximum applied pressure exceeding the maximum gauge pressure.

B. Install pressure snubbers to reduce pulsations at or near discharge of centrifugal pumps. Not required at other locations.

1.4 SUBMITTALS

A. Submit product literature for each type of gauge, in accordance with the General Provisions. Submittal shall be appended with a list that correlates Manufacturer's model numbers with specified type and installation location.

B. Where mounting bracket assembly is required, Contractor shall submit details of the arrangement for approval.

1.5 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010.

PART 2 - PRODUCTS

2.1 PRESSURE GAUGES

A. Type 1: Located at all pump suction lines.

1. Compound Range: 30-inch Hg vacuum to 15-psi or 30-psi.
2. Stainless steel case with ¼ inch stem out bottom.
3. 2.5-inch to 80mm glycerin-filled dial.
4. Type 316 stainless steel Bourdon tube and connections.
5. Make direct connection with Type 316 stainless steel gauge cock.

B. Type 2: Located at all pump discharge and appurtenant equipment influent and effluent lines (such as heat exchangers, sterilizers, sensor bypass lines, etc.).

1. Range: Zero to 30-psi.
2. Stainless steel case with ¼ inch stem out back preferred for installation in vertical pipe (out bottom acceptable).
3. 2.5-inch to 80mm glycerin-filled dial.
4. Type 316 stainless steel Bourdon tube and connections.
5. Make direct connection with Type 316 stainless steel gauge cock.

C. Type 3: Located at all large diameter (four foot and larger) pressure filter effluent lines.

1. Range: Zero to 15-psi.
2. Stainless steel or plastic case with ½ Inch stem out bottom.
3. 3.5-inch to 4.5-inch dial.
4. Type 316 stainless steel Bourdon tube and connections.
5. Make direct connection with ½ inch Type 316 stainless steel gauge cock.

D. Type 4: Located in pressurized ozone gas supply lines to eductor influents.

1. Range: 30-inch Hg vacuum to 15-psi pressure; or 10-inch to 10-psi.
2. Stainless steel casing.
3. 3-inch to 80mm dial with 0.5-inch and/or 0.2-psi graduations with 1/4 inch stem out bottom.
4. Type 316 stainless or Monel connections and Bourdon tube or actuation capsule.
5. Make direct connection with Type 316 stainless steel gauge cock.
6. Supply specified 30-inch to 15-psi gauge with overload and underload stops; or supply as 30-inch to 30-psi "retard" type gauge; or supply with over-pressure safety valve.

E. Miscellaneous Pressure Gauges: All pressure gauges used for the LSS shall be one of the types listed above, unless specifically approved otherwise by the Engineer. Clarification regarding type of pressure gauge required for specific application shall be obtained from the Engineer prior to installation

F. Manufacturers:

1. *Ametek U.S. Gauge Division* (compound gauge with lower stem) Sellersville, PA (215) 257-6531 www.ametek.com;
2. *Ashcroft/Dresser Instrument* Stratford, CT (203) 378-8281 www.dresser.com/instruments;
3. *H.O. Trerice Co.* Oak Park, MI (248) 399-8000 www.trerice.com;
4. *Weksler Instruments Corp*. Freeport, NY (561) 988-8003;
5. *WIKA Instrument Corporation* Lawrenceville, GA 30043 (770) 513-8200 or (888)945-2872 www.wika.com;

6. or approved substitute.

2.2 GAUGE COCKS

A. PVC uni-body type gauge cock body, EPDM seats and seals, with lever handle. Longitudinal in-line design with two 1/4-inch female threaded pipe connections.

B. Manufacturer: *Hayward Industrial Products Inc*., Elizabeth, NJ (908) 351-5400*;* or approved substitute.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Direct Mount: Install gauge cock between gauge and pipe connection. Anti-seize thread compound must be used in addition to Teflon tape.

B. Indirect Mount: If gauges cannot be mounted directly to the gauge cock, the Contractor shall provide an additional mounting bracket assembly. Connect with Type 316 stainless steel sample tubing, or polypropylene tubing for water applications, or Type 316 braided stainless steel flexible hose lined with TFE (Teflon) manufactured by Cajon Company (Swagelok) Macedonia, OH or approved substitute.

C. Pressure Snubbers: Install pressure snubbers where gauge is at or near discharge of centrifugal pumps. Not required at other locations.

D. Where installed at pump suction and discharge ports, provided adapter fittings and pipe or tubing, as required, for vibration-free installation of pressure gauges.

END OF SECTION

SECTION 170430 - TEMPERATURE DEVICES

PART 1 - GENERAL (See 170010)

1.1 USAGE

A. The thermometers and sensing wells are used in:

1. 49 deg F to 80 deg F aquarium seawater.

1.2 SUMMARY

A. The General Conditions shall apply to this Section as fully as if stated herein.

B. Contractor shall purchase and install thermowells and thermometers adjacent to influent and effluent of heat exchangers, and at all other locations indicated on the Piping and Instrumentation Diagrams.

1.3 COORDINATION

A. Coordinate with Automated Controls System.

B. Coordinate length of thermowells with water pipe size and size of inner temperature probe.

C. Electrical Contractor shall provide all conduits; provide, pull and terminate all wiring from temperature transmitters to controls cabinets. Termination shall consist of installing hard wiring for completion of circuits at termination points. Temperature transmitters shall be installed with 3-wire cable.

D. Line-Of-Sight Locations: Install common specified mercury thermometers where reading can be clearly seen and accessed at floor level by operational staff.

1.4 QUALITY ASSURANCE

A. Testing Laboratory Requirements: Acceptable qualified testing laboratories shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) for Labels on Electrical & Mechanical Equipment. Acceptable listing agencies include Canadian Standards Association (CSA), Intertek Testing Services ITS-ETL, and Underwriters Laboratory (UL). Depending on the “Equipment Category” other testing agencies may be qualified by the State of North Carolina; such as NSF International, National Technical Systems (NTS), or other approved research laboratories.

1. The manufacturer shall be fully responsible for compliance with this requirement.
2. The specified equipment is available on request from *Pyromation* as an assembly with a CSA testing laboratory accreditation.
3. If field approval is necessary to meet listing requirements, it shall be completed without delay to the project and at no additional cost to the Owner.

1.5 SUBMITTALS

A. Submit manufacturer's information describing the products. Where manufacturer's part numbers are submitted, submittal shall include factory description of order codes.

B. Submit proof that installed materials will bear approved testing agency listing mark or classification markings.

1.6 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010.

PART 2 - PRODUCTS

2.1 MERCURY THERMOMETERS

A. Red reading liquid column in glass; adjustable to any angle; maximum 2-degree divisions on scale; 2-degree accuracy throughout entire scale; one-piece aluminum V-shaped case, dual Fahrenheit and Celsius scales, with front glass; adjustable angle stem.

B. Stem: Type 304 stainless steel where available, brass stem where stainless is not available.

C. Scale: 7-inch (9-inch where 7-inch not available), dual deg F & deg C.

D. Temperature range shall be:

1. For circulating process water: 0 °F to 120°F & -15°C to 48°C (or 20°F to 120°F) with 1-degree graduations.
2. For heating water: 30 °F to 240°F & 0°C to 115°C with 2-degree.
3. For chilling water: 0 °F to 120°F & -15°C to 48°C with 1-degree graduations.

E. Manufacturer:

1. *Weksler* Deer Park, NY (866) 415-2002 www.weksler-gauges.com;
2. *Trerice Company* (Series A405) Oak Park, MI (248) 399-8000;
3. or approved substitute.

2.2 SENSING WELLS / THERMOWELLS

A. Thermowell, in water piping for receiving of temperature probe, with ½-inch NPT hex nipple, filled with a non-solidifying heat conducting paste.

1. Sensor well diameter: 0.375-inch or 0.5-inch.
2. Sensor Well Length: As required for diameter of water piping and length of temperature probe.
3. Male Tap Thread Diameter: 0.5-inch MPT
4. Female End Thread Diameter: 0.5-inch FPT.

B. Materials: Titanium, Hastelloy, or AL6XN.

C. Manufacturers:

1. *AquaLogic* www.aqualogicinc.com (Titanium available);
2. *Delta Hydronics* www.deltahydro.com (Titanium available);
3. *Pioneer Enterprise* www.favfittings.com (Hastelloy available);
4. Approved substitute.

2.3 TEMPERATURE SENSORS / TRANSMITTERS

A. Product: RDT temperature sensor with transmitter installed in weatherproof non-metallic head. Delivered from the manufacture as a complete assembly with the thermowell.

B. Description: The given descriptions shall prevail over the suggested Model or Part Numbers.

1. Fluid Immersion Sensor: Platinum RTD element, 100 ohms with accuracy +/- 0.56 deg. F at 32 deg. F.

   a. *Pyromation* Order Number: R1T185L483 thermowell, SC element.
   b. *Weed* Model: 723-PB.

2. Head Housing: Polypropylene body and cap, chain for cap retention, with weatherproof gasket. The protection rating shall be no less than IP 65 with the transmitter installed.

   a. *Pyromation* Order Number: 63C or 8HN22.
   b. *Weed* Model: 05.

3. Transmitter: PC programmable for converting the resistance input signal into a scalable 4 to 20 mA output signal given a 24 VDC voltage from the Automated Controls System (ACS). 3-wire circuit for resistance adjustment. Transmitter installed in the polycarbonate sensor head. Rated for 95% max. relative humidity.

   a. *Pyromation* Order Number: T31-385U-S(0-100)F
   b. *Weed* Model: 4600H.

4. Thermowell: Per above specified requirements.

   a. *Pyromation* Order Number: ST4CZSSXX and as specified above.
   b. *Weed* Model: As specified above.

C. Exterior Cover by Contractor: For outdoor locations, provide a non-metallic housing or marine canvas cover with grommets and nylon cord. For additional protection of the IP-65 rated polypropylene head against deterioration by sunlight and weather.

D. Manufacturers:

1. *Weed* by *Ultra Electronics,* Round Rock, TX (800) 880-9333 or (512) 434-2850 www.ultra.energy/weedinstrument/;
2. *Pyromation RTD,* Fort Wayne, IN, telephone (260) 484-2580 www.pyromation.com.

PART 3 - EXECUTION (See 170010)

3.1 INSTALLATION

A. Install at all locations indicated on the P&ID drawings.

B. Mercury Thermometers: Install for visibility by operational staff; however, do not install thermometers projecting out into pathways where they would be prone to damage.

C. Thermowells: Locate thermowells such that they are in the path of moving fluid and not positioned in stagnant or dead-end locations. Wells shall not obstruct the flow of the fluid being measured. Pipes one-inch and smaller shall be increased as required. Install thermowell with both Teflon tape, and a liberal coating of PTFE pipe dope, on the pipe threads. Fill thermowells with a non-solidifying heat conducting paste with installation of temperature probes.

D. Final: Complete installation of wiring of temperature transmitters to automated controls system or temperature controller and demonstrate functionality to Owner's satisfaction.

END OF SECTION

SECTION 170441 - MAGNETIC FLOW MONITORS

PART 1 - GENERAL (See Section 170010)

1.1 SUMMARY

A. Provide all flow meters where indicated on the drawings, including all "diagrams" and "standard details," and as specified herein. The General Conditions shall apply to this Section as fully as if stated herein.

B. The required locations are indicated on the P&ID drawing as "FS" and "FM" *for flow sensor* and *flow monitor* respectively. Flow monitors are also known transmitters.

C. Flow Monitor Types:

1. Pitot Tube Type as specified in Section 170447. Where indicated on the Drawings with no connection to the Automated Controls System (ACS). No wiring is required.
2. Mag-Meter Type, as specified in Part 2.1 below. Arrange valves and fittings to allow the longest possible straight piping run where Mag-Meter Type sensors are installed.

D. Contractor shall be responsible for selection of transmitter/indicator locations depending on best line-of-sight options. Provide necessary FRP mount stanchions, brackets and hardware for separately mounted transmitter/indicators. May be mounted on FRP “Instrument Stand” by *Champion Strut,* Spring, TX (281) 655-8900 www.championfiberglass.com

1.2 QUALITY ASSURANCE

A. Testing Laboratory Requirements: Acceptable qualified testing laboratories shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) for Labels on Electrical & Mechanical Equipment. Acceptable listing agencies include Canadian Standards Association (CSA), Intertek Testing Services ITS-ETL, and Underwriters Laboratory (UL). Depending on the “Equipment Category” other testing agencies may be qualified by the State of North Carolina; such as NSF International and other approved research laboratories. The manufacturer shall be fully responsible for compliance with this requirement. If field approval is necessary to meet listing requirements, it shall be completed without delay to the project and at no additional cost to the Owner.

1.3 SUBMITTALS

A. Submit Manufacturer's brochures for the flow sensors and transmitters, dimensional information, electrical requirements, and information on installation fittings and other related piping specialties.

B. Submit information describing the NEMA-4X instrument enclosure.

C. Submit information on 24 VDC power supplies where required.

1.4 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010.

1.5 COORDINATION

A. At filters, install flow sensors in the center of the piping run to allow sensor to read flow in forward and reverse directions. Order flow sensors configured by supplier for forward and reverse flow where required. The lay lengths shown in the Contract Documents shall be considered as minimum and the Contractor shall not reduce the lay length without written approval of specifying engineer—this lay length is the distance between fittings where the flow sensor is installed.

B. Perform all necessary coordination with Automated Controls System (ACS) supplier and ascertain provision of all required work.

C. Electrical Contractor shall provide all conduit; provide, pull and terminate all low-voltage wiring from flow transmitters to controls cabinets. Termination shall consist of completing hard wiring for completion of circuits at termination points. Electrical Contractor shall provide power wiring.

D. Coordinate power as required:

1. GF 2581 FlowtraMag® require a separate 24 VDC power cable.
2. GF 2551 Mag-Meters are powered from the cable to the transmitter. The 2581 is equipped with factory-installed cables, while cables for the 2551 are to be field-installed shielded 3-wire.
3. GF 9900 Transmitters are supplied 120 VAC power.

E. Data/Communications Wiring: Shall be separate from power wiring.

1. Output cables from GF 2581 FlowtraMag® and GF 2551 Mag-Meters flow sensors, to transmitters, shall be cabling for S^3L signal. The 2581 is equipped with factory-installed cables. Cables for the 2551 are to be field-installed shielded 3-wire, provide *Belden* 8772, 20 AWG, 3-wire; or equal.
2. Output from 9900 transmitters shall be 24 VDC “loop powered” 4-20 mA cabling from the automated controls system (ACS).
3. Where “2-wire” for low-voltage 4–20 mA control wiring is not specifically called out on Drawings, or Electrical Documents, or by ACS supplier, provide *Belden* 9802, 2 conductor, 20 AWG, with PP insulation; or equal.

F. Power Supply Options: All flow meters and transmitters are to be powered through the ACS cabinet.

G. Field-Mounts & Enclosures: Coordinate the required field-mount accessory or enclosure as required per the selected transmitter, power supply, and installed location.

1.6 WARRANTY

A. The manufacture shall warranty the entire package assembly to be free of defects in material and workmanship for not less than 1-year after startup of the water treatment system and not less than purchase of the units by the installing Contractor. The manufacture shall replace any components found defective within the warranty period.

PART 2 - PRODUCTS

2.1 MAG-METER FLOW SENSORS FOR 6-INCH AND LARGER PIPING

A. Application: Flow meters, with display transmitter or connection to ACS, for 6-inch and larger pipe shall be mag-meter type as specified below.

B. Design: Insertion style magnetic flow sensor that features no moving parts capable of reading bi-directional water flow. Order sensor with the required length for field-installed pipe fittings. It is preferable that sensors are delivered with jumper wiring, required for reading bi-directional water flow, to be factory-installed in the delivered product.

C. Operational Parameters: Suitable for reading flow from water with a minimum conductivity of 20 µS/cm. Flow rate range of 0.15 to 33 ft/s. Water temperature range from 32 to 185 deg F. Maximum water pressure of 150 psig at 77 deg F.

D. Non-Wet Materials:
1. Case: PBT plastic with NEMA 4X/IP65 protection rating.
2. Type 316L stainless steel screws and miscellaneous alloy components.

E. Wetted Materials:
1. Upstream of Ozone: polypropylene (PP) body; Type titanium electrodes; and FPM, FKM, or EPDM O-rings.
2. Downstream of Ozone: PVDF body, titanium electrodes, and Kalrez (FFKM) O-rings

F. GF 2551 Sensor Installation Fittings:

1. PVC Pipe 8-inch & Smaller: Provide PVC "Clamp-On" type Sensor Installation Fitting by *GF Signet*.

G. Manufacturer and Model: GF Signet 2551 Mag-Meter Flow Sensor by *GF Signet*, www.gfps.com.

2.2 TRANSMITTER FLOW MONITOR

A. Used for receiving S^3L/frequency signal from flow sensor, transmitting signal to the automated controls system (ACS), and displaying flow rates locally. Shatter-resistant glass window; bright LCD screen with digital readout of flow and units and a “Dial-type” digital bar graph; with external keys for set-up and calibration of output. Housing Material of PBT plastic with NEMA 4X/IP 65 front.

B. Temperature range from 14 deg F to 158 deg F. Accuracy +/- 0.5% of reading.

C. Signal Output: Externally powered 4 to 20 mA current signal.

D. Power Requirements: Transmitter will receive 120 VAC power from the ACS cabinet. Provide the monitor box assembly with a 120 VAC to 24 VDC transformer.

E. Flow Indicator shall include standard NEMA 4X/IP 65 front cover and mounting bracket.

F. Manufacturer: *Georg Fischer Inc.* Irvine, CA, telephone (800) 854-4090 or (714) 731-8800 www.gfps.com

2.3 TRANSMITTER HOUSINGS

A. Provide housings matching transmitter requirements.

1. Housing for 9900 Transmitters: Use for installation of transmitters and factory installed 120 VAC / 24 VDC power supply. The housing shall be a NEMA-4X instrument enclosure, by *GF Signet*, 11.31" x 13.31" x 5.59" with 316 SS door hinge and latches, ¼ DIN cutout for transmitter, DIN rail for mounting of power supply with terminals, conduit holes with liquid-tight grommets; or industry standard substitute.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as recommended by the Manufacturer and as indicated on the drawings. Where instrumentation is located outdoors, install to match manufacturer's recommended installation requirements; do not install in direct sunlight; provide protective covering as required to prevent damage from sunlight, or weathering, or revise location as required.

B. Transmitter/Indicators shall be located for ease of visible reading from equipment service area. Do not install face of monitor in direct sunlight or provide sunshade.

C. Power, control wiring and related conduits shall be supplied, pulled, terminated and connected to correct contacts by the Contractor. All work shall be performed to Code regulations and quality references given in the Electrical Specification Subsection.

D. Install flow meters and related instruments with ground wires and shielding per manufacturer's recommendations. Connect the ground terminals with 14 AWG directly to a local earth ground. Install shielded cable, connected only at remote instruments, but do not connect the shield at the Mag-Meter sensor — per manufacturer's recommendations.

1. 2551 Magmeter requires field-installed shielded 3-wire, provide *Belden* 8772, 20 AWG, 3-wire; or equal.

E. Prior to arrival of the ACS supplier for installation of controls software, verify proper installation of all flow measurement and related devices and perform all calibration and necessary adjustments.

F. Technical Seminar: Contractor shall coordinate a "Technical Seminar" presented by manufacturer's technical representative to the Owner's maintenance and operations staff.

END OF SECTION

SECTION 170446 - FLOW ROTAMETERS

PART 1 - GENERAL (See Section 170010)

1.1 USAGE

A. Ozone gas (5.5% ozone gas, 90% oxygen, 4.5% dry air), air, or saltwater, as indicated on the Drawings.

1.2 SUMMARY

A. Provide all rotameters where indicated on the drawings, including all "diagrams" and "standard details," and as specified herein. The General Conditions shall apply to this Section as fully as if stated herein.

1.3 SUBMITTALS

A. Submit Manufacturer's brochures, dimensional information, and information on installation fittings and other related piping specialties. Submit scale units, dual metric and SCFH preferred.

B. Submit factory recommendations for calibration with applied gas and pressures, or saltwater flows.

1.4 COORDINATION

A. If used for metering ozone gas (5.5% ozone gas, 90% oxygen, 4.5% dry air), coordinate percent ozone produced by actual installed ozone generating equipment.

B. Where used for metering ozone gas, coordinate with installation of ozone gas metering panels if such panels are proposed for the installation.

PART 2 - PRODUCTS

2.1 OZONE GAS FLOW ROTAMETERS

A. Type: Variable area float meters. The brand model selected by supplier for conditions and ozone gas flow rates shown on the Drawings.

B. Usage: External environment is indoors. Internal service is ozonized oxygen (5.5% ozone gas, 90% oxygen, 4.5% dry air).

C. Materials:

1. Tube: Glass for ozone service.
2. Float: *Teflon,* glass, Type 316 SS, Hastelloy, or Tantalum.
3. Seals: *Teflon*.
4. Safety Cage: 300 Series stainless steel frame with polycarbonate shields.
5. End Connections: Resistant to oxidation by ozone for ozone service. Panel mount or straight-through as required for proposed installation.

D. Scale: Dual Metric and SCFH preferred. Submit to owner for approval prior to shipping.

2.2 AIR OR WATER FLOW ROTAMETERS

A. Type: Variable area float meters. The brand model selected by supplier for conditions and flow rates shown on the Drawings.

B. Usage: External environment is indoors. Internal service is air, compressed air, or water.

C. Materials:

1. Tube: Acrylic or Polysulfone.
2. Float: *Teflon,* glass, Type 316 SS, Hastelloy, or Tantalum.
3. Seals: *Teflon* or Viton.
4. End Connections: Series 300 SS or plastic for air service. Type 316 stainless steel for saltwater service.

D. Scale: SCFH for air. GPM for water.

E. Options: Needle valve at base mount

PART 3 - EXECUTION (See Section 170010)

3.1 INSTALLATION

A. Install as recommended by the Manufacturer and as indicated on the drawings.

B. Install flow indicators in a visible location.

END OF SECTION

SECTION 170455 – ORP AND pH MONITORING

PART 1 - GENERAL

1.1 LOCATIONS

A. Model 9900 Transmitters shall be used for single-point one-to-one ORP sensor monitoring.

1.2 GENERAL REQUIREMENTS

A. ORP and pH sensors shall be installed where indicated on the Drawings including all "diagrams" and "standard details" and as specified herein. The General Conditions apply to this Section as fully as if repeated herein.

B. The sensors are used in 55 to 85 deg F ozonized saltwater.

C. The work consists of:

1. Installing ORP sensors at locations shown on the LSS Drawings for indication of ORP and/or monitoring of ORP readings by the automated controls system and for controlling the ozone generator's rates of production.
2. Installing pH sensors at locations shown on the LSS Drawings for indication of pH and/or monitoring of pH readings by the automated controls system

1.3 QUALITY ASSURANCE

A. Testing Laboratory Requirements: Acceptable qualified testing laboratories shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) for Labels on Electrical & Mechanical Equipment. Acceptable listing agencies include Canadian Standards Association (CSA), Intertek Testing Services ITS-ETL, and Underwriters Laboratory (UL). Depending on the “Equipment Category” other testing agencies may be qualified by the State of North Carolina; such as NSF International and other approved research laboratories. The manufacturer shall be fully responsible for compliance with this requirement. If field approval is necessary to meet listing requirements, it shall be completed without delay to the project and at no additional cost to the Owner.

1.4 SUBMITTALS

A. Submit Manufacturer's brochures, dimensional information, electrical requirements, and information on installation fittings and other related piping specialties.

B. Submit information for 24 VDC power supply transformer and enclosures

C. Submit factory warranty information.

1.5 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010.

1.6 GENERAL COORDINATION

A. Coordinate the type of ORP/pH sensor electrode with the system design. Use platinum-tipped ORP sensors for ozone, hypochlorite bleach, or calcium hypochlorite

B. Coordinate with Automated Controls System (ACS) wiring requirements.

C. Power Supply: All display transmitters shall be powered with 120 VAC power from the ACS cabinet. All ORP sensors shall be powered from the 9900 single display transmitter.

PART 2 - PRODUCTS

2.1 PACKAGED ASSEMBLY — OPTION 1 BY GEORG-FISCHER

A. The complete assembly for the ORP/pH sensor and integral display transmitter shall be delivered by GF Signet supplier, to contractor.

B. “Wet Tap” style ORP sensors, capable of reading the oxidation reduction potential (ORP) from -2000 to +2000 mV range.

C. Sensor shall consist of the following components integrated into a single package from the manufacturer:

1. Electrode: Signet 2757-WTP electrode with DryLoc electrical connection for ORP. Signet 2756-WTP electrode with DryLoc electrical connection for pH.
2. Preamplifier with Dry Lock: *Signet* 2751 NEMA 4X construction with a DryLoc connection for the ORP/pH electrode.

D. Equip the ORP sensor package with integrated the G-F *Signet* 9900 transmitter known at the “Field Mount” transmitter.

E. Transmitter: Used for receiving signal from *Signet* 2751 ORP/pH Sensor, transmitting signal to the Owners Automated Controls System (ACS) and displaying ORP/pH locally. Shatterproof glass window; bright Human Machine Interface (HMI) screen with digital readout of ORP in mV units and a “Dial-type” digital bar graph; with external keys for set-up and calibration of output. Housing Material of ABS plastic with NEMA 4X/IP 65 front cover.

1. Input signal compatible with *Signet* 2751 ORP/pH Sensor.
2. Temperature range from 14 deg F to 158 deg F.
3. Accuracy +/- 0.5% of reading.
4. Signal Output: Externally powered 4 to 20 mA current signal.
5. Power Requirements: Transmitter will receive 120 VAC power from the ACS cabinet. Provide the monitor box assembly with a 120 VAC to 24 VDC transformer.
6. Model: *Signet* 9900 ORP Monitor by *G-F Signet*.

F. Angle Adapter Adjustment Kit 396 by *G-F Signet*. Installed in between the sensor preamplifier and the transmitter/monitor.

G. Close-end nipple fitting, and any other parts required for completion of the complete assembly.

H. Provide threaded tee-fitting or PVC "saddle" fitting.

I. Power Supply Transformer: Provide a 24 VDC power supply for 85 to 264 VAC input, mounted in a NEMA-4X Enclosure with conduit holes equipped with liquid-tight wiring connections. *By G-F Signet*; or approved substitute.

J. Option 1 Supplier: *Signet by Georg Fischer Inc.* Tustin, CA (800) 854-4090 or (714) 731-8800 www.us.piping.georgefischer.com.

2.2 PACKAGED ASSEMBLY — OPTION 2 BY OZONE WATER SYSTEMS

A. The complete assembly for the ORP/pH sensor and indicating transmitter shall be delivered by Ozone Water Systems, to contractor, as follows with all products having supplier-verified part numbers:

1. Clear Acrylic Wet-Tap Assembly with bolt-on PVC saddle fitting.
2. ORP/pH Electrode by *G-F Signet*.
3. ORP/pH Sensor Electronics by *G-F Signet*.
4. Housing-Mounted Indicating Transmitter with 120 VAC/24 VDC power supply.
5. Pipe Saddle Mount.

B. Wet Tap Assembly: Wet tap assembly shall allow for sensor replacement, maintenance, and calibration without shutdown of the process water flow. The sensor block shall be constructed of clear acrylic sensor block to show any build-up or contamination on the probe. Shall include multiple sensor ports including one (1) 3/4” and three (3) 1/2” ports for male National Tapered Pipe Thread (MNPT) sensor installation, and one (1) water sample port materials shall consist of PVC, acrylic; EPDM, Kalrez or Viton rubber; and Type 316 SS or superior alloy metals. Shall include a Carpenter 20 alloy sensor grounding electrode.

C. ORP/pH sensor consisting of electrode and preamplifier, capable of reading the oxidation reduction potential (ORP) from -2000 to +2000 mV range.

D. Housing-Mounted Transmitter and Power Supply:

1. Housing for 9900 Transmitters: Use for installation of 9900 transmitter and 120 VAC / 24 VDC power supply, factory installed. The housing shall be a NEMA-4X instrument enclosure, by G-F Signet, 11.31” x 13.31” x 5.59” with 316 SS door hinge and latches, ¼ DIN cutout for transmitter, DIN rail for mounting of power supply with terminals, conduit holes with liquid-tight grommets; or industry standard substitute.

E. Option 2 Supplier: *Ozone Water Systems,* Phoenix, Arizona (480) 421-2400 www.ozonewatersystems.com;

2.3 ORP and pH CALIBRATION EQUIPMENT

A. Obtain necessary solutions, pH buffer kit, instructions, and apparatus for calibration of sensors and turn over to Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install sensors at locations indicated on drawings and per Manufacturer's recommendations. Establish in an orientation that facilitates maintenance and does not permit air binding. Install sensor fitting at the 10-O'clock or 2-O'clock positions where possible.

B. Install ORP/pH transmitter and housing within 5-feet of respective sensor location, per Manufacturer's instructions, serviceable for calibrating and so displays are easily viewed.

C. Install shielded conductor from sensor to transmitter in one-half inch flexible conduit and mount securely. Connect grounding wire to earth ground separate of other electronic equipment.

D. Install housings with power supplies as required.

E. Install power supplies and ACS comm wiring. Install shielded conductor from sensor to transmitter in one-half inch flexible conduit and mount securely. Connect grounding wire to earth ground separate of other electronic equipment.

F. Contractor shall complete installation of ORP and pH sensors and transmitters, calibrate the display in mV, and demonstrate the display functionality to the Owner's satisfaction.

G. Contractor shall coordinate a "Technical Seminar" presented by manufacturer's technical representative to the Owner's maintenance and operations staff. Seminar shall provide instruction on removal and replacement of ORP/pH probes, cleaning, and demonstration of calibration.

END OF SECTION

SECTION 170467 - CO2 FEEDER & ACCESSORIES

PART 1 - GENERAL

1.1 GENERAL

A. This specification is for a package of equipment for feeding CO2 gas, as specified below, including the following items:

1. CO2 Feeder.
2. In-Line Heater.
3. Gas Pressure Regulator.
4. 3/8” CO2 gas tubing.
5. Couplings and fittings, as required for installation of the CO2 gas tubing.
6. Diffuser with fitting for connection to PVC piping.
7. CO2 Monitor and Alarm.
8. Contractor shall provide two (2) initial 20 lb. CO2 gas cylinders for startup of the system. May be obtained from a local reputable welding gas supplier.

1.2 COORDINATION

A. Coordinate pH sensor via LSS ACS, to this CO2 Feeder, for activation of CO2 feeding when lowering of pH is required.

B. Coordinate installation of electrical outlets for 120 VAC to the In-Liner Heater.

C. Complete water piping and gas tubing installation as required.

1.3 QUALITY ASSURANCE

A. Testing Laboratory Requirements: Acceptable qualified testing laboratories shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) for Labels on Electrical & Mechanical Equipment. Acceptable listing agencies include Canadian Standards Association (CSA), Intertek Testing Services ITS-ETL, and Underwriters Laboratory (UL). Depending on the “Equipment Category” other testing agencies may be qualified by the State of North Carolina; such as NSF International and other approved research laboratories. The manufacturer/supplier shall be fully responsible for compliance with this requirement. If field approval is necessary to meet listing requirements, it shall be completed without delay to the project and at no additional cost to the Owner.

1.4 SUBMITTAL INFORMATION

A. Catalog cuts and sufficient data for each specified item in the package of equipment.

B. Submit proof that installed materials will bear approved testing agency listing mark or classification markings.

C. Submit warranty. The manufacture's standard start of the warranty period, at delivery, may require revision for compliance with this specification.

1.5 WARRANTY

A. Warranty: Installed equipment shall be guaranteed against defective parts for a minimum of 2-years from the date of delivery.

1.6 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 240010.

1.7 SUPPLIER OF PACKAGED EQUIPMENT

A. All specified equipment shall be provided by the supplier as a single package.

B. Direct suppliers if available from the listed suppliers with an approved testing laboratory label:

1. *ProMinent Fluid Controls, Inc*. Pittsburgh, PA (412) 787-2484 www.prominent.us;
2. *Link Automation*, a division of Mer Made Filter, Ramsey, NJ, telephone (201) 236-0217.
3. or an approved substitute.

C. If re-packaging is required for an approved testing laboratory label, the Contactor shall order specified equipment provided with an approved label delivered from one of the following suppliers:

1. *Ozone Water Systems*, Phoenix, Arizona Tel: (480) 421-2400 www.ozonewatersystems.com;
2. Approved substitute.

PART 2 - PRODUCTS

2.1 CO2 FEEDER

A. NEMA 4X polycarbonate enclosure for housing terminal strip, solenoid valve, internal tubing and wiring, and for mounting of flowmeter and selector switch. The feeder shall be designed to receive control signal from the (ACS) and provide easy installation, reliable performance and safe operation.

B. Feed Rate: Designed for delivery of 10 – 100 SCFH.

A. Water Flow Meter: Shall include variable area float meter, also known as rotameters. By Blue-White Industries Westminster, www.bluwhite.com; Gilmont Instruments www.barnant.com; or King Instruments, www.kinginstruments.

B. Solenoid Valve: Shall include a reliable, quite operating, normally closed, solenoid valve.

C. Electrical Power: 120 VAC, 50/60 Hz, 15 VA maximum.

D. Manufacturers: *ProMinent Fluid Controls, Inc.*; *Link Automation*, a division of Mer Made Filter; or an approved substitute.

2.2 IN-LINE HEATER

A. In-line heater designed to prevent CO2 regulator freeze-up. 120 VAC single phase. *Profax*, supplied by *Airgas*; or equal.

2.3 GAS PRESSURE REGULATOR

A. Two-Stage Gas Pressure Regulator: Designed for reducing the high-pressure CO2 gas, with a constant lower pressure at the outlet. Equipped with a spring, diaphragms, and adjustment knobs. Shall be a two-stage regulator, with the first stage reducing pressure to approximately 90 psi, and the second stage reducing gas pressure to 0 to 15 psi. Bronze body and internal materials compatible with CO2 gas.

B. Regulator Connector: Bronze regulator connector, for Compressed Gas Association (CGA) Type 320. With no less than 12 extra use-once flat washers, provided to the Owner.

C. Manufacturer: Harris www.harrisproductsgroup.com or equal.

2.4 DIFFUSER INJECTOR

A. Diffuser for injection of CO2 gas into water piping.

1. ProMinent CO2 Feeder: P/N 7746926 CO2-D-L Diffuser, use only for 50 SCFM maximum applications.
2. Link Automation: Injection/Check Valve as provided by manufacturer.

2.5 TUBING AND FITTINGS

A. Gas Tubing: Polyethylene compatible with CO2 gas and equipped with union connectors as required. Typically a 50-ft length of tubing by the supplier of the CO2 feeder.

B. Manufacturer: John Guest, or equal

2.6 CO2 MONITOR AND ALARM

A. Dioxide Monitor: Wall-mounted ambient CO2 gas monitor, with alarm, for protection of the facility staff personnel against excessive CO2 gas in the environment. Must be recommended by the manufacture for personnel breathing safety. Accuracy of +/- 100 ppm CO2, or lower value, at the installed detection range. Equipped with a visual alarm display and an auditory alarm. Provided with a 120 VAC to 24 VDC transformer power supply as required.

B. Electrical Power: 120 VAC; or 120 VAC to power supply with low-voltage to the monitor.

C. Manufacturers: Honeywell, ATI, Sensaphone, or approved substitute.

2.7 CO2 CYLINDER

A. Pressurized CO2 Cylinders: 20 lb. 7.75-inch diameter size, commercial grade pressurized liquid CO2, in 1,800 psi cylinders, from of reputable source, such as a welding gas supplier, or www.beveragelements.com; or equal.

PART 3 - EXECUTION (See Section 170010)

3.1 INSTALLATION BY CONTRACTOR

A. Install package of equipment to provide a fully operational and complete working system as per these specifications, the construction drawings, and the Manufacturer's recommendations.

B. Contractor shall ensure electrical equipment is in conformance with a approved testing laboratory listing and bears certification labeling.

C. Mount wall-mounted equipment on walls as required. Where equipment cannot be wall-mounted, install with products specific in Sections 240310 and 240316 and/or stanchion-mount.

D. Install 120 VAC wiring as required. Outlet plug may need to be removed tor hard-wiring to the Chemical Analyzer. The heater may be either, plugged in directly to a wall outlet, or split-off from the 120 VAC wiring from the relay of the Chemical Analyzer.

E. Deliver extra use-once flat washers, used at the pressure regulator, to the Owner.

END OF SECTION

SECTION 170476 - PRESSURE TRANSMITTERS

PART 1 - GENERAL

1.1 USAGE

A. The pressure transducers are used for measurement of saltwater surface elevations.

1. Pressure transducers with the “PLSM01” tag number shall have the capability for keeping water level within a range of +/- 0.10-inch elevation and are installed with a separate wall-mounted transmitter. These are required for water level measurement at all exhibit tanks with surface skimmers in addition to any other locations identified on the Drawings.
2. Pressure transmitters with the “PLSM02” tag number shall have the capability for keeping water level within a range of +/- 0.84-inch elevation and are equipped with integral transmitter with LED display.

1.2 SUMMARY

A. The General Conditions shall apply to this Section as fully as if repeated herein.

B. Locations: Provide where indicated on the drawings, including all "Diagrams" and as specified herein.

1.3 COORDINATION

A. Installing contractor shall coordinate available transducer pressure ranges with the installed conditions.

B. Contractor shall provide 24 VDC loop power from the ACS cabinet as indicated on the LSC drawings.

1.4 QUALITY ASSURANCE

A. Testing Laboratory Requirements: Acceptable qualified testing laboratories shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) for Labels on Electrical & Mechanical Equipment. Acceptable listing agencies include Canadian Standards Association (CSA), Intertek Testing Services ITS-ETL, and Underwriters Laboratory (UL). Depending on the “Equipment Category” other testing agencies may be qualified by the State of North Carolina; such as NSF International and other approved research laboratories. The manufacturer shall be fully responsible for compliance with this requirement. If field approval is necessary to meet listing requirements, it shall be completed without delay to the project and at no additional cost to the Owner.

1.5 SUBMITTALS

A. Submit product literature for each type of device, in accordance with the General Provisions.

1 1.6 MAINTENANCE AND OPERATIONAL DATA

2 A. Include pertinent information in the project bound Operations & Maintenance Data Manual per
3 requirements in Section 170010.

4 PART 2 - PRODUCTS

5 2.1 PLSM01 PRESSURE TRANSDUCERS (Installation at 3.0-ft max water depth)

6 A. Locations: Where “PLSM01” is called out on the Drawings.

7 B. Pressure Transmitter: Unit equipped with ¼-inch NPT male instrument connection with NEMA
8 4X sealed electronics. Type 316L SS housing, with integral junction box, and Type 316L SS
9 process connections. Pressure transducing by means of polysilicon strain gauge.

10 1. Range: 0 to 1.5 psi.
11 2. Diaphragm: Type 316L stainless steel.
12 3. Output Signal: 4 - 20 mA loop powered output.
13 4. Power requirements: 10 to 36 VDC, unregulated, 3 mA maximum.

14 C. Model and Manufacturer: Model E2G Pressure Transducer, by *Ashcroft Inc.* Stratford, CT
15 www.ashcroft.com or approved equal

16 2.2 PLSM02 PRESSURE TRANSMITTERS (Installation at 20.0-ft max water depth)

17 A. Locations: Where “PLSM02” is called out on the Drawings.

18 B. Pressure Transmitter: Unit equipped with ¼-inch NPT male instrument connection with NEMA
19 4X sealed electronics. Type 316L SS housing, with integral junction box, and Type 316L SS
20 process connections. Pressure transducing by means of polysilicon strain gauge.

21 1. Range: 0 to 10 psi.
22 2. Diaphragm: Type 316L stainless steel.
23 3. Output Signal: 4 - 20 mA loop powered output.
24 4. Power requirements: 10 to 36 VDC, unregulated, 3 mA maximum.

25 C. Model and Manufacturer: Model E2G Pressure Transducer, by *Ashcroft Inc.* Stratford, CT
26 www.ashcroft.com or approved equal

27 2.3 INDICATING GAUGE

28 A. For all PLSM02 pressure transducers, provide indicating pressure gauge, "Type 2" per Section
29 170641, for local readout and calibration of pressure sensor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Elevation: Do not install 1.5 psi range transducer lower than 3.0-ft below the water surface.

B. Provide 0.5-inch ball valve (as a pressure gauge cock) between gauge and pipe connection.

C. Install common analog indicating pressure gauge, in-line, after the gauge cock and before the pressure transmitter.

D. Install separate low-voltage power and comm wiring the transmitter/display monitor.

E. Calibrate the transmitter display to read the water pressure and correlated to the correct water surface elevation and demonstrate functionality to the Owner's satisfaction.

END OF SECTION

SECTION 170584 - NON-METALLIC AIR BLOWERS

PART 1 - GENERAL (See Section 170010)

1.1 USAGE

A. The air blowers are used to blow air into, and exhaust moist salty air out from the top, of the Sand Tiger Shark deaeration tower.

1.2 REQUIREMENTS

A. Blower capacity, pressure, speed, type, and other requirements shall be as indicated on the Drawings.

B. Blower, electric motor, and specified items shall be supplied as a complete pre-assembled packaged unit on a skid mount frame. The inlet silencer may be provided with the blower assembly, or provided separately, and field assembled.

1.3 CODES

A. Comply with all applicable codes listed in Section 170010 and conform to ASME B19.1, "Safety Standard for Air Compressor Systems."

B. Comply with standards set by the Air Movement and Control Association (AMCA) for drive and blower arrangements.

1.4 COORDINATION

A. When placing the order, coordinate the required drive arrangement, discharge and inlet box position, and motor position for each specific flower installation. This may require sending of shop drawings to the blower supplier for coordination. Use standards of the Air Movement and Control Association (AMCA) when coordinating the arrangements.

B. Variable Frequency Drives (VFDs) are to be provided, as indicated on the Equipment Schedule, per the Electrical Contract Documents.

1.5 SUBMITTALS

A. Data shall be prepared by the blower and/or motor manufacturer and shall include:

1. Name of blower manufacturer and model number.
2. Dimensional drawing of packaged equipment.
3. Characteristic curves showing: Flow quantity, pressure, speed, and horsepower.
4. Complete blower description plus material list including: Housing, rotors, seals, and shaft.
5. Submit AMCA fan and drive arrangements for each delivered unit.
6. Name of motor manufacturer and supporting data for: Nominal, horsepower, speed at full load.

7. Warranty.

B. Submit required accessories.

1.6 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010.

1.7 WARRANTY

A. Warranty: Guaranteed against defective parts for a minimum of 1-year from the date of startup in the complete system, or 1-year after Owner acceptance of the units from the installing Contractor, whichever is less.

PART 2 - PRODUCTS

2.1 PLASTIC BLOWERS

A. Type: The blower shall use a radial wheel and constructed of corrosion-resistant materials and suitable for continuous 24-hour duty. Direct-direct drive with speed adjustment by VFD.

B. Construction:

1. Scroll housing and blower wheel shall be made of polypropylene, or fiber reinforced polypropylene, or similar non-metallic materials
2. Dynamically balanced and factory tested.
3. Equipped with a drain plug at the bottom of the scroll housing.

C. Motors: Factory equipped with a direct-drive electric motor, VAC and RPM speed per Equipment Schedule on the Drawings. Variable Frequency Drive (VFD) capability per Equipment Schedule on the Drawings.

D. Base: Equipped with a corrosion-resistance, Type 316 stainless steel, base support of the motor.

1. The components shall be assembled so that routine or annual maintenance can be performed without undo disassembly.
2. Exterior Coating: All ferrous metal parts shall be coated with a zinc-rich primer followed by a durable top-coating for superior corrosion resistance.

E. Required accessories:

1. Provide inlet screen/guard on the blower intake for protection.
2. Provide Flex PVC connector at air blower suction and discharge per blower manufacturer recommendations.
3. Provide adjustable CPVC butterfly damper per blower manufacturer.

F. Manufacturer:

1. *Plastec,* Bradenton, FL (941) 751-7596 www.plasticventilation.com;

2. Or equal model by, *Harrington Plastics*;
3. Approved substitute.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractor shall mount the equipment as shown on the drawings and make all necessary connections and adjustments for a complete and correct installation. All air lines shall be purged of foreign debris before starting.

B. Installation shall include a secure connection of the inlet silencer to the air blower with the complete assembly operational without any rattling sounds.

C. Install electrical power, including VFD capability, per Electrical Contract Documents.

D. Test as recommended by the manufacturer and demonstrate functionality to the Owner.

END OF SECTION

SECTION 170586 - ROTARY BLOWER PACKAGE

PART 1 - GENERAL (See Section 170010)

1.1 USAGE

A. Tag No. GEN-ABO001-001. The blower is used to provide low pressure air to miscellaneous aquarist air uses.

1.2 REQUIREMENTS

A. Blower capacity, pressure, speed, type, and other requirements shall be as indicated on the drawings.

B. Provide blower, electric motor, filter, muffler and other specified accessory items as a complete pre-assembled packaged unit on a skid mount frame.

1.3 CODES

A. Comply with all applicable codes listed in the General Provisions and conform to ASME B19.1, "Safety Standard for Air Compressor Systems."

1.4 SUBMITTALS

A. Supply the following data:

1. Dimensional drawing of all equipment.
2. Characteristic curves showing: Flow quantity, pressure, efficiency, and horsepower.
3. Complete description plus material list including: Casing, rotors, seals, shaft.
4. Submit information on all “Accessories.”
5. Name of motor manufacturer and supporting data.
6. Copy of two (2) year warranty.
7. Submit type 316 stainless steel piping information.

1.5 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010.

1.6 WARRANTY

A. Warranty: Guaranteed against defective parts for a minimum of 1-year from Substantial Completion.

PART 2 - PRODUCTS

2.1 ROTARY TYPE BLOWER

A. Type: Rotary blower package to include rotary lobe type blower packaged in a sound attenuating enclosure that allows all maintenance access from the front of the blower. Suitable for heavy-duty continuous industrial service. Blower shall be oil-free, positive displacement, rotary lobe type designed for air service. IEC IP-54 for superior dust and splash-tight enclosure.

1. Silencers: Equipped with inlet and discharge absorption silencers. Discharge silencer designed to designed to reduce noise by 5-8 dBA.

2. Air Filter: Equipped with “Com-paK Plus” Rotary Blower Package by Kaeser Compressors inlet air filter.

3. Expansion Joints: Provide where required for sound attenuation and vibration reduction.

4. Pressure Relief Valve: Equipped with a spring-loaded relief valve installed on the discharge silencer. Shall prevent blower dead head air flow condition. Set relief pressure for valve per manufacturer’s recommendations.

5. Motor: Motor shall be energy efficient, IE3, with thermistors, with speed controlled by VFD. Unit shall include a speed monitor.

6. Ventilation Fan: Provided in the enclosure to ensure proper cooling.

7. Drive: V-belt drive with automatic tensioner and fully-enclosed belt guard.

8. Blower Construction: Precision machined or die-cast surfaces and dynamically balanced. Blower may be close-coupled to the electric motor; or mounted in tandem with enclosed drive belt if installation allows.

9. Indicators: Temperature gauge, pressure gauges on inlet and outlet.

B. Electrical: The package shall be delivered from the factory for a single point of connection for electrical power.

C. Performance: Air flow with a 3.0 psig differential: 19 SCFM at minimum frequency, 60 SCFM at design point, and 65 SCFM at maximum frequency.

D. Make & Model: “Com-paK Plus” Rotary Blower Package, BB 52 package with Omega 21P blower, by *Kaeser Compressors*, Fredericksburg, Virginia (540) 898-5500; or approved substitute.

2.2 TRANSMISSION PIPING

A. Piping Material at Discharge:

1. Installed for a minimum length of 10-ft after the blower for heat dissipation.
2. Pipe: Schedule 10 Type 316 Stainless Steel piping or better. Conforming to ASTM A312 ASME SA312.

3. Fittings: Type 316 Stainless steel threaded fittings acceptable

B. Compressed Air Piping: See specification 170233 for air piping to be installed after the SS heat dissipation piping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount equipment as shown on the drawings and make all necessary connections and adjustments for a complete and correct installation.

B. Purge air lines of foreign debris before starting.

END OF SECTION

SECTION 170666 - PLATE-TYPE HEAT EXCHANGERS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide heat exchangers of quantity and capacities as given on the Equipment Schedule of the Drawings. The General Conditions apply to this Section as fully as if stated herein.

B. Governing Parameter: The delivered heat exchangers shall not be sized for less than the "minimum capacity" given on the drawing equipment schedule. If adjustments in design parameters are required, the manufacture shall make slight adjustment to the water flow rate for chilling or slight adjustment in the temperature differential for heating. The maximum pressure differentials shall remain a 5.0 psi.

1.2 SUBMITTALS

A. Catalog cuts and sufficient data including temperatures in and out, flow rates, pressure drops, effective transfer area, dimensions, weight, nozzle size and location, and material schedule. Include information on stainless steel support feet.

B. Computer sizing information/calculations shall be included with submittal and shall be stamped and signed by a Registered Professional Engineer.

C. Submit price list for replacement plates, gaskets, and other commonly use parts.

D. Submit 1-year guarantee.

1.3 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010.

1.4 CODES, STANDARDS AND TESTING

A. Shall be designed, fabricated, and tested in accordance with the applicable Sections of the ASME Code for Un-fired Pressure Vessels, Section VIII, Division I. Code stamping is required.

B. After complete assembly but before shipment, the exchanger shall be hydrostatic tested in accordance with the requirements of ASME Section VIII, Division 1.

1.5 INSPECTION REPORTS AND CERTIFICATES

A. Manufacturer's Data Report: The Seller's data report should contain the following documents in the English language and British Units (i.e., BTU's). Form U-1 (Paragraph UG-120 of the ASME Code) with the applicable sections properly filled out.

1.6 MANUFACTURERS GUARANTEE AND WARRANTY

A. Guarantee and Contractor's Warranty: Prior to acceptance of the units, the Manufacturer shall furnish a written guarantee of the equipment for no less than 1-year of trouble-free service, backed in full for 100% material costs. Manufacturer shall warrant and guarantee all equipment furnished to be free from defects in materials for a minimum of 1-year from the date of startup of the complete system, or 1-year after Owner acceptance of the units from the installing Contractor, whichever date occurs first. Manufacturer's warranty shall not relieve the Contractor from furnishing a complete system warranty as specified in the General Conditions.

PART 2 - PRODUCTS

2.1 PROCESS

A. Heat Transfer Fluids: Pool fluid will be ozone treated saltwater, specific gravity of 1.03. Heating/chilling fluid will be a solution of 0% glycol in water.

B. Shall be single pass, counter-current flow design, with all end connections on the stationary cover plate.

C. Frame shall be designed to permit future installation of a minimum of 15% additional plates in addition to 10-percent excess plate area for fouling.

D. Maximum velocity through extended flanged nozzles shall be 16.0 fps. Maximum velocity through stud-port nozzles shall be 11.0 fps.

E. Minimum velocity between plates shall be 0.5 fps.

F. The maximum allowable overall pressure drop shall be five psi.

G. Computer print-out shall give data for theoretical plate area with 0% fouling factor. To account for the specified fouling factor, the heat exchanger shall be delivered with the excess number of plates as required for an additional 10% plate area.

H. Process water bypassing is not allowed. Temperature requirements shall be met at the inlet and outlet nozzles without the use of internal or external bypassing of process water.

2.2 CONSTRUCTION

A. Plate and frame heat exchanger of new design and current manufacture, ASME construction, and labeled for 100 psi working pressure at 265°F in accordance with Section VIII, Division 1 of ASME Code for un-fired pressure vessels.

B. Connection nozzles shall accommodate ANSI B16.5 connections. May be equipped with either flanged pipe nozzles (16 FPS max.) or oversized stud-port type connections (11 FPS max.).

C. Plates:

1. The minimum thickness of plates before pressing shall be 0.5 mm (0.020 inch) nominal and of adequate rigidity for independent hydrostatic testing of each circuit separately.

2. Port holes not feeding passes between plates shall be fully gasketed and vented to the atmosphere, and relieving grooves shall be located such that leakage of liquids cannot occur without external evidence.
3. Plates shall be of one-piece design, without seams. Additional "loose" type hanger straps are acceptable.
4. The heat exchanger shall be delivered with 10% excess plate area to allow for fouling.

D. Fixed and Movable Covers: Shall have all nozzle/flange connections located on the stationary cover plate.

E. Compression Bolts and Nuts: The compression bolt length shall accommodate the provision for 15% additional future plates—in addition to the 10% plate area for fouling provided by plates delivered with the heat exchanger.

F. Plate Gaskets:

1. An FDA approved "Food Grade" adhesive compound compatible with the gasket material; or glue-less gasketing.
2. One-piece gaskets are required.
3. The compressed plate pack dimension shall be given on the seller's assembly drawing. This dimension shall also be shown on the permanent nameplate attached to each respective heat exchanger.

G. Handling Devices: Permanent lifting points shall be provided to handle the exchanger.

H. Materials for Saltwater Process:

1. Frame: Carbon steel SA-515 or SA-516 Grade 60/70.
2. Plates: Titanium, Grade 1; or better.
3. Tie Rods: All-thread Type 316, 317, 416 or 417 stainless steel.
4. Nuts: Dissimilar stainless steel from the rod metal to avoid metal transfer and seizing.
5. Gaskets: Resin-cured butyl rubber or EPDM rubber (vendor to verify selection of gasket material for specific application).
6. Splash Shield: Aluminum or stainless steel.
7. Upper & Lower Carrying Bars: Type 316 stainless steel, solid or clad.
8. All Nozzles: Solid titanium or titanium-lined carbon steel.
9. Support Feet/Angles: Type 304 stainless steel.

I. Materials for Freshwater Process:

1. Frame: Carbon steel SA-515 or SA-516 Grade 60/70.
2. Plates: Type 316 stainless steel; or better.
3. Tie Rods: All-thread Type 304 stainless steel.
4. Nuts: Dissimilar stainless steel from the rod metal to avoid metal transfer and seizing.
5. Gaskets: Resin-cured butyl rubber or EPDM rubber (vendor to verify selection of gasket material for specific application).
6. Splash Shield: Aluminum or stainless steel.
   Upper & Lower Carrying Bars: 300 Series stainless steel, solid or clad.
7. Connection Nozzles: Solid Type 316 stainless steel or Type 316 stainless steel-lined carbon steel.
8. Support Feet/Angles: Type 304 stainless steel.

2.3 FACTORY APPLIED COATING

A. Carbon Steel Components: *Special Order* with *corrosion resistant* coating required on all carbon steel surfaces.

1. Surface Preparation: Break all sharp edges by grinding or filing to prevent "pin-pointing" of coating. Prepare base metal with abrasive blast for a Commercial Finish immediately before application of coating.
2. Required Prime Coating: Prime coat of inorganic zinc primer, *Carboline* "Carbo Zinc 11 HS" or approved substitute.
3. Topcoat for Outdoor Installations: Two (2) topcoats with water-borne acrylic enamel, *Carboline* "D3359" for outdoor exposure to sunlight; or approved UV resistant substitute; or two (2) coats *Amerlock 2* epoxy, followed by final topcoat of *PPG Spectracron 380* or equal product with excellent exterior color and gloss retention.
4. Topcoat for Indoor Installations: Two (2) topcoats with water-borne acrylic enamel; or aliphatic urethane gloss enamel; or a two-part epoxy finish.

B. Titanium, aluminum, and stainless steel surfaces shall not be factory painted.

2.4 DATA PLATE & I.D.

A. Mount a permanent stainless steel data plate with the following information:

1. Manufacturer’s name
2. Model number
3. Unique serial number
4. Design pressure drop across both sets of nozzles
5. Design temperatures at each nozzle

B. Clearly label each nozzle for in or out and fluid type.

2.5 PREPARATION FOR SHIPMENT

A. Surface Protection: Machined surfaces exposed to the atmosphere shall be suitably protected from saltwater spray and corrosive material during shipment by means of an easily removable rust preventive coating of satisfactory consistency.

2.6 SPARES

A. Manufacturer shall maintain a stock of spare parts within the country where unit is installed; spares shall be available upon demand; submit replacement price list of plates, gaskets, and other commonly use parts.

2.7 MANUFACTURERS

A. Manufacturers:

1. *Alpha-Laval Inc.*, Richmond, VA (804) 222-5300 or San Diego, CA (858) 569-1300 www.alphalaval.com;
2. *APV Crepaco Inc.*, (937) 558-7518 www.apv.com;

3. *Autopropac,* Orem, UT www.autopropac.com;
4. *Delta Hydronics,* Hudson FL (727) 861-2421 www.deltahydro.com;
5. *S.A. Armstrong Limited,* Toronto, Ontario (416) 755-2291;
6. *Bell and Gossett (ITT Fluid Handling Corporation),* Morton Grove, IL (847) 9666-3700 www.bellgossett.com;
7. *Graham Corporation,* Batavia, NY (585) 343-2216 www.graham-mfg.com;
8. *Mueller Accutherm (Paul Mueller Company),* Springfield, MO (417) 831-3000 www.muel.com;
9. *Tranter PHE Inc.*, http://us.tranter.com;
10. or approved substitute.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in strict accordance with the Manufacturer's recommendations.

B. Provide concrete housekeeping pads.

C. Install butterfly valves at heat exchanger for all process fluids only after increasing line size to size of transmission piping shown on the drawings.

D. Install Type 316 stainless steel vent-cocks at all high points on vent lines or as otherwise indicated on the drawings.

E. Install gauge connector plugs and/or pressure gauges and/or thermometers as specified elsewhere.

F. Field-coat exposed stainless steel and aluminum metal surfaces with penetrating lubricant finish specified in Section 170010.

G. Balance heat exchanger flows as follows:

1. Balance cold chilling water, and hot heating water flow, as required by the Mechanical Engineer.
2. When running in the cold-water chilling mode, for the LSS/pool side of the heat exchangers, check for a temperature differential within 2 degrees F plus or minus of temperature differentials given in the Heat Exchanger Schedule on the Drawings.
3. When running hot water heating mode, for the LSS/pool side of the heat exchangers, check for a temperature differential within 4 degrees F plus or minus of temperature differentials given in the Heat Exchanger Schedule on the Drawings.
4. If the differential temperatures are low, throttle the outlet valve of the LSS/pool heat exchanger pump to achieve the correct differential temperature and/or increase the flow of cold chilling water or hot heating water. If excessive throttling of LSS heat exchanger pump is required, issue a report to the Owner that the heat exchanger may not be performing as specified.
5. If the differential temperature on the LSS/pool side of the heat exchanger is excessive, then reduce the flow of cold chilling water or hot heating water, flowing from the Mechanical side thru the heat exchanger.

END OF SECTION

SECTION 170667 - TUBE TYPE HEAT EXCHANGERS

PART 1 - GENERAL

1.1 USAGE

A. The heat exchangers are used in filtered saltwater process water for small aquatic animal exhibits.

1.2 SUMMARY

A. Provide heat exchangers of quantity and capacities as given on the Heat Exchanger Schedule of the Drawings and as specified herein. The General Conditions apply to this Section as fully as if stated herein.

1.3 COORDINATION

A. Provide with factory supplied Type 316 stainless steel mounts to match with installed situations.

1. Factory wall-mount support where installed wall-mounted.
2. Factory floor stands where floor mounted.

B. Hot and cold water piping and valves must be coordinated with the LSS ACS design requirements.

1.4 SUBMITTALS

A. Catalog cuts and sufficient data including temperatures in and out, flow rates, pressure drops, dimensions, weight, nozzle size and location, and material schedule.

B. Submit warranty.

1.5 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010.

1.6 WARRANTEE

A. The warranty period shall begin at startup of the water treatment system, or at Owner acceptance of the units from the installing Contractor, or starting 6-months from date of shipment, whichever is less. Unless warranted by a longer manufacturer's warrantee, the manufacture shall replace any components found defective within a 1-year warranty period.

PART 2 - PRODUCTS

2.1 TUBE TYPE HEAT EXCHANGER

A. Provide heat exchanger packaged as a single unit mounted on a stainless steel mounting rack/stand.

B. Performance: Heat exchangers shall deliver the scheduled minimum Ton chilling rate, or Btu/hr heating rate, at the differential temperature indicated on the Equipment Schedule.

C. Housing Shell: Constructed of Schedule 40 or Schedule 80 CPVC.

D. Inner Tubing: Titanium.

E. Pressure loss shall be less than 5-psi.

F. Insulation: Main cylinder of body wrapped with closed-cell insulation.

G. Support Rack: The tube shall be delivered with a support rack for wall or floor mounting, of Type 316 stainless steel or Type 304 stainless steel with a superior corrosion-resistant coating.

H. Manufacturers of Tube Type Heat Exchangers:

1. *AquaLogic, Inc.*, San Diego, CA (858) 292-4773 www.aqualogicinc.com;
2. *Delta Hydronics,* Hudson FL (727) 861-2421 www.deltahydro.com;

PART 3 - EXECUTION

3.1 INSTALLATION BY CONTRACTOR

A. Install in accordance with the Manufacturer's recommendations.

B. Provide mounting brackets and bracing as required.

C. Install valves at heat exchanger for all process fluids only after increasing line size to size of transmission piping shown on the drawings.

D. Install thermometers thermowells as specified in specification Section 170430.

E. Contractor shall startup, verify performance of heat exchangers, and demonstrate functionality to Owner.

END OF SECTION

SECTION 170723
OZONE GENERATION EQUIPMENT

PART 1 - GENERAL (See Section 170010)

1.1 SUMMARY

A. Ozone gas generators and related equipment shall be supplied as specified herein. The size and location shall be as indicated on the Drawings. The General Conditions shall apply to this Section as fully as if repeated herein.

B. The ozone generators, and all equipment specified within, interlocks, and appurtenances, including labor, shall be furnished by a single Ozone Systems component provider as a complete system. The Ozone Systems component provider shall provide all components per specifications, accurate submittals of components for review, installation assistance, operation instruction, and training for ozone system components as specified below. A single vendor shall be selected by the Contractor to provide all equipment in this specification Section, including the following items:

1. Air-Cooled Ozone Generators: As scheduled on Drawing LS0.03.
2. Backflow Prevention: Each ozone generator to be equipped with, or served by, a device for active prevention of water from back-flowing into the generator from the ozone gas piping.
3. Air Preparation Equipment: As indicated on the Drawings and as specified below.
4. Off-Gas Decomposers: Type “A” at pressure ozone contactors, Type “B” at deaeration towers and fractionators, and Type “C” for exhausting dual containment ozone gas piping.
5. Ambient Ozone Monitors: Located in each equipment room with potential ozone and remote ozone sensors where called for on Drawings.
6. External Warning Devices: Located at the entry to each room with potential ozone.
7. Safety Equipment Cabinets: One located outside of the ozone equipment room and outside the fractionator room.
8. Signage: Safety warnings as required by Code.

C. Equipment/Products: The Ozone Systems component provider shall provide the following equipment and services:

1. All specified products in this Section including ozone generators and other specified ozonation equipment.
2. Submit technical information for approval of equipment prior to delivery.
3. Installation consultation and recommendations as required for other sub-contractors and consultants to install the delivered ozone equipment.
4. Startup of system, testing, commissioning of equipment and systems.
5. Training of Aquarium operations staff.
6. Warranty of all specified equipment.

1.2 QUALITY ASSURANCE

A. New equipment of current design and backed by practical testing and successful installations. All the equipment specified within shall be furnished as a package from a single source.

B. “Standard 250 for Enclosures for Electrical Equipment” shall be used as a guide for fabrication of the ozone generator cabinets: National Electric Manufacturers Association, 2101 L Street, N.W., Suite 300, Washington, DC 20037.

C. The Ozone Systems component provider shall provide assistance for meeting the requirements in the National Fire Protection Association (NFPA) code as related specifically to the components of the specified ozone equipment. However, the Ozone Systems component provider shall not be responsible for obtaining permits, or code compliance, with elements of the building including, but not limited to, existing equipment, building materials, ventilation, automated controls, and transmission pipes through the building envelope to the outdoors.

D. This specification assumes that NFPA 1 - Uniform Fire Code - 2003 Edition, Annex G Ozone Gas-Generating Equipment, has been adopted by the regulating officials in jurisdiction where the equipment is being installed.

E. Testing Laboratory Requirements: Acceptable qualified testing laboratories shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) for Labels on Electrical & Mechanical Equipment. Acceptable listing agencies include Canadian Standards Association (CSA), Intertek Testing Services ITS-ETL, and Underwriters Laboratory (UL). Depending on the "Equipment Category" other testing agencies may be qualified by the State of North Carolina; such as NSF International and other approved research laboratories. The manufacturer shall be fully responsible for compliance with this requirement. If field approval is necessary to meet listing requirements, it shall be completed without delay to the project and at no additional cost to the Owner.

1.3 SUBMITTALS

A. Catalog cuts and sufficient data including capacities, flow rates, pressures, name of sub-component manufacturers and model numbers and dimensional drawings of packaged equipment.

B. Submit proof that installed materials will bear approved testing agency listing mark or classification markings.

C. Provide complete schematics, complete description of operation, control schematics including coordination with other electrical control devices.

D. Submit list of specified and recommended spare parts.

E. Submit performance Guarantee for generator and Warrantee on dielectrics.

F. Submit description of Start-Up Services.

G. Where Contractor selects an alternate manufacturer from the listed Base Supplier, the Contractor shall list all modifications required for the alternate product to match the Contract Drawings including Shop Drawings of the alternate product with the Submittal.

1.4 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010.

1.5 COORDINATION

A. Coordinate work with installation of automated controls, a.k.a. LSS ACS.

B. Coordinate selected equipment's electrical power requirements with final field conditions.

C. See other specification Sections for related equipment:

1. 170261 for ozone gas piping. The entire ozone gas supply line, interconnecting piping, and off-gas ducting supplied by and installed by the Contractor as specified in Ozone Gas Piping Specification Section 170261.
2. 170288 for Mazzei ozone gas injectors.
3. 170454 for ORP monitors.
4. 170805 for pressure ozone contactor vessels

1.6 GUARANTEE & WARRANTY

A. The Ozone Systems supplier shall be responsible for factory warrantees for all related peripheral equipment.

B. The supplier shall guarantee all equipment to be free from defects in manufacturing, workmanship or materials, and shall repair or replace defective equipment within one year from Substantial Completion. The manufacturer shall guarantee the documented power consumption, hour test capacity and production of the ozone generator.

C. The dielectrics shall have a non-prorated 100% warrantee for three-year life. For failure of any dielectric, for any reason other than breakage by mischievous physical tampering, the supplier shall deliver new dielectrics to the Owner within 24 hours.

1.7 FACTORY START-UP ASSISTANCE AND TRAINING

A. Technical Construction Assistance Visits: The ozone systems component provider shall provide at least two visits for assistance with installation of the new system.

B. Field visits visit(s) to assist with equipment, completion of automated controls, debugging of the system, and completion of a final punch list of work performed by others. At the completion, of installation of all equipment, the component provider shall commission all ozonation equipment by verification of service limitations, calibration of sensors and instrumentation, and proof of function of all operational variables.

C. Training Seminar: ozone systems component provider shall provide a personnel training visit, separate, or in combination with the equipment commissioning visit. The component provider's senior personnel to give complete formal seminar on the fundamentals, routine operation, standard maintenance, and rebuilding instruction demonstrations for the ozone generators and all other ozonation equipment. Shall include educational material handouts for the Aquarium staff, demonstration of actual components and visual aids.

1.8 OZONE EQUIPMENT SUPPLIERS

A. Base Suppliers: The Drawings and specified equipment conforms to equipment available from the following base supplier:

1. *Ozone Water Systems*, Phoenix, Arizona Tel: (480) 421-2400
www.ozonewatersystems.com;

B. Alternate Suppliers: Selection by the Contractor of the following alternate suppliers may result in variations from detailing on the Drawings resulting in the preparation of shop drawings by the Contractor to account for modifications. The Contractor's selection of Alternate ozone suppliers will require coordination of space for the physical equipment well as coordination for alternate electrical power requirements. Any required changes to accommodate an alternate is the Contractor's responsibility The following suppliers may or may not be able to supply equipment and/or ozone generators as specified:

1. *Telchine Research & Development*, LLC rob@telchine-rd.com
Largo, FL 33773 Telephone: (727) 385-2328

2. *International Ozone Services*, Inc. www.io3service.com.
Mount Dora, FL 32757 Telephone: 321.238.8097

PART 2 - PRODUCTS

2.1 AIR-COOLED OZONE GENERATORS

A. Type: Ozone generators shall be self-cooled or air-cooled corona discharge type. U.V. bulb type generators are not acceptable. All components used within the ozone generators shall be constructed of ozone-resistant materials.

B. Capacity: Production capacity of ozone generators shall as scheduled on the Life Support Drawings. Generators shall produce ozone gas using air as feed source to a percentage within the range of 1.5% to 2.75% by weight.

C. Manual Control Devices. The ozone generator/control cabinet shall be equipped with the following devices for manual settings:

1. Power supply on switch.
2. Emergency stop button (oversized and “red” in color).
3. Local / Remote or HOA switch. Capacity adjustable by way of a manual output control dial or adjusted fully automatically on Ethernet signal from the LSS ACS.
4. Gas pressure control valve.

D. Production Chambers: Each ozone generator may consist of one or more independent ozone production chamber(s). Each cathode within the production chamber shall be constructed of 316L stainless steel with Teflon end caps.

E. The ozone generator shall be capable of operating continuously for a period of one (1) year without a major cleaning of internal components. No degradation of materials including tubing, fittings, O-rings or wiring shall occur for a minimum of three (3) years. Design environmental conditions are as follows:

1. Min./Max. temperature: 40 to 95 degrees F continuously.
2. Humidity: 20% - 90% relative humidity, non-condensing environment.
3. Line voltage: +/- 10% rated input.

F. Emergency Shut-Off: The ozone generator skid shall have a red manual shut down button for the ozone generators within 10-ft of the exit door.

G. Each ozone generator shall be factory tested for a minimum of 8 hours. Testing of the generator’s output shall be per the Water Quality Association (WQA) Testing Methodology Guideline criteria for rating ozone output in grams per hour and percent concentration (by weight) at specific feed gas flow rates.

H. Generators shall have a label stating serial number, date of manufacture, ozone output, model number and address of manufacturer affixed to the side.

I. Monitoring Features: Each generator include an *Ethernet* connection for electronic communication of the following status items:

3. Run Status
4. Gas Flow
5. Gas Pressure
6. Display of dielectric power consumption (Wattmeter)
7. Cabinet Temperature
8. Display of faults such as high temperature, electrical shorts, voltage out of limit, set points out of limit, et cetera

9. In-service hour counter
10. Back Flow Preventer Status

J. Output Adjustment: Each ozone generator shall have the functionality via an Ethernet connection to the LSS ACS:

1. Remote Start
2. Remote Stop
3. Ramp Up Ozone Production
4. Ramp Down Ozone Production

K. Air Flow Meter: A physical air flow meter, with variable area float, shall be mounted on or in the cabinet.

L. Ozone Gas Piping:

1. Internal Piping: Internal feed gas, ozone delivery lines, and fittings shall be made of Kynar, Teflon, or Type 316 stainless steel.
2. External Piping: All external ozone gas piping shall be in accordance with specification Section 170261.

M. Electrical Power: Refer to equipment schedule for power. Equipped with a main fuse; separately fused transformer; and separately fused cooling fans where applicable; permanent external labeling of proper fuse sizes. All insulated internal electrical wiring jacketed with ozone resistant materials to prevent deterioration.

N. External Interlocks: Ozone generators shall interface with the LSS ACS through the Interface Control Panel in the Ozone Generator Enclosure. The Control panel shall communicate with the ACS through an ethernet connection.

1. High Ambient Ozone: Upon closed contact switch on the ambient ozone monitor, the related ozone generators shall stop production of ozone. System may restart automatically upon open switch on the ambient ozone monitor.
2. Ozone Injection Pump Status: ACS programming shall not allow production of ozone without conformation of run status of related ozone injectors.
3. Off-Gas Destruct Status: ACS programming shall not allow production of ozone without conformation of run status of related off-gas destruct unit.
4. Dew Point Monitor: Following a short time delay ozone production shall be curtailed on a high dew point in the feed gas. System shall remain off until a manual restart is initiated.

2.2 BACKFLOW PREVENTION

A. Supply one ozone and saltwater corrosion resistant check valve with each generator at the inlet to an active backflow prevention device described below.

B. For each ozone generator, supply an active backflow prevention device consisting of a mechanical float valve and normally closed valve designed to positively prevent backflow of water into the generator.

1. Provide an automatic mechanism to shut down and or purge the ozone generator if liquid backs up inside the ozone gas line between the gas injection point and the ozone generator.
2. Shall include a clear glass enclosure for observation of correct functionality.
3. All related gas connections will be capable of sustaining an operating pressure of 45 psi or full vacuum.
4. Blue “Alarm Clear” indicator lamp and red “Alarm” condition lamp.
5. Termination or relays for alarm for clear dry status condition.

2.3 LOW-VOLTAGE CONTROL WIRING

A. Control Wiring: Where low-voltage is not provided at limited locations. Where “2-wire” for low-voltage 4 – 20mA control wiring is required, provide *Belden* 9802, 2 conductor, 20 AWG, with PP insulation; or equal

2.4 AIR PREPARATION EQUIPMENT

A. General: The Air Preparation Equipment shall consist of gear necessary to supply feed gas to all ozone generators from a single reliable source. No single piece of equipment mounted on the skid shall produce more than a 76 dB sound level (air compressor shall produce less than 72 dB) and optional mufflers and/or enclosures shall be provided as required.

B. Process Train: The air preparation system shall consist of, but not limited to, the following series of apparatus:
   1. Rotary Air Compressors (2).
   2. Particulate and Coalescing Filters* (2).
   3. Refrigerated Air Dryer* (2).
   4. Air Receiver Tank (1, with automatic condensate drain).
   5. Oxygen concentrator (1).
   6. Oxygen Receiver Tank (1).
   7. Desiccant air dryer, on by-pass for alternate duty (1).

   * Note filters and refrigerated air dryer may be combined with the compressor unit

C. Rotary Air Compressor: Either an oil-less rotary scroll type air compressor, or a oil lubricated rotary screw type compressor with ultra-filtration.
   1. Compressor shall be packaged in an enclosed sound attenuation cabinet with a noise level less than 72 DBA.
   2. Shall be an industrial rotary screw air compressor designed for 24-hour, quiet vibration-free operation. Direct or vee-belt drive. Shall include an oversized heavy-duty inlet air filter, and air-cooling fan.
   3. Vent Connection: Shall be constructed for venting of cooling air connected to ducting for discharge out of Ozone Equipment Room.
   4. Motor shall be TEFC, 480, 60 hertz. Equipped with a separate U.L. certified electrical power disconnect switch. Provide motor starter in control panel, if required.
   5. Instrument panel incorporating pressure gauge, temperature gauge, hour meter, HOA switch. Include U.L. listed controls for automatic start/stop operation. Provide high temperature shut-down switch and diagnostic light, and pressure control switch.
   6. If an oil lubricated rotary screw type compressor is selected, equip with an oversized oil separator/filtration to allow for extended operation and prevent any oil contamination of the ozone generator's dielectric cells. Provided with a differential pressure switch and high pressure warning lamp to indicate loading of filter.
   7. Manufacturers of oil-less rotary scroll type air compressors:
      a. Kaeser
      b. *Atlas Copco Compressors Inc*. Holyoke, MA (413) 536-0600;
      c. *Powerex* (with specified options and spare parts) Harrison, OH (513) 367-3120;
      d. or approved substitute

D. Particulate and Coalescing Filters: Provide particulate and coalescing filter after the receiver. Include condensate trap automatically operating bleed-off valve. Manufactured by:
   1. Domnick Hunter Inc. Charlotte, NC (704) 568-8788;
   2. or approved substitute.

E. Refrigerated Dryer: Provide an industrial, direct expansion type, refrigerated dryer intended by the manufacturer for continuous 24 hour duty. Dryer may be integral with air compressor. Manufactured by:
   1. *Pneumatech Inc*. Kenosha, WI (414) 658-4317;
   2. *Airtek* Lancaster, NY (716) 685-4040 www.airtek.com;
   3. or appropriate substitute.

F. External Receiver: Vertically oriented ASME Code VIII air receiving tank, separate of the air

compressor, with auto-condensate drain devise.

1. Size the air receiver to limit total compressor start-ups to less than six times per hour at maximum ozone generator demand. 60 gallon minimum.

G. Equip receiver with automatically purging condensate drain based on liquid level sensing. Device shall use electronic water level sensors, not a mechanical float mechanism, and shall discharge only condensate water and not compressed air. BEKOMAT from *Benz Engineering* Montebello, CA (800) 698-1250 www.benzcas.com; or approved substitute

H. Condensate Drains: Equip air receiver, coalescing filters, and other condensate traps with automatically purging condensate drain.

I. Oxygen Concentrator: Oxygen concentration device using pressure swing absorption technology. Designed for continuous 24 hour duty. Minimum purity of oxygen produced shall be no less than necessary for ozone generator=s requirements to produce the specified ozone. Shall be piped internally and externally with copper piping and brass or stainless steel fittings; plastic piping components are not allowed. Pressure purge valves shall be equipped with muffler to limit maximum sound level to less than 76 dB. Manufactured by:

1. *Air Sep*; *OSIG, Inc*. Niagara Falls, NY;
2. or approved substitute.

J. Oxygen Receiver Tank: ASME Code VIII air receiving tank.

K. All feed gas piping shall be of stainless steel piping cleaned for oxygen service.

2.5 OFF-GAS DECOMPOSERS

A. Type “A”: Off-Gas Decomposers at Contactors without Blower.

1. Location: Off-gas unit operating on system pressure shall be installed, downstream of pressure ozone contactor, as shown on the drawings.
2. The off-gas decomposer shall be designed to destroy all residual ozone gas from pressurized discharge. The contact process shall be assumed to be zero-percent efficient in reducing the applied ozone gas. The unit shall be supplied as a complete integrated package for wall or stanchion mounting. Equip with U.L. certified electrical power disconnect switch.
3. De-mister: Constructed of ozone and saltwater spray resistant materials (Type 316 grade stainless steel or non-metallic construction); capable of removing foam and water particles damaging to the catalytic elements. Where installed outdoors, constructed of opaque U.V. resistant materials. Include drain trap where installed remote of ozone contactor. Manufactured by the ozone equipment supplier.
4. Heater: Resistance-type constructed of Type 316 stainless steel and controlled by an integrated circuit controller to provide the minimum low temperature required by catalytic unit.
5. Catalytic Canister: Shall be sized for destruct of 100% of the applied ozone. The unit shall not be "optimized" to operate at a temperature higher than 200 deg. F maximum
6. The destruct unit shall be provided with a water trap/demister assembly to remove condensate from the off gas and ensure moisture getting into the catalyst canister.
7. Materials: Housing shall be constructed of Type 316 stainless steel.

B. Type “B”: Large Off-Gas Decomposers with Blower.

1. Locations: For use for drawing off-gas from gravity contact tower and for drawing off-gas from fractionators.
2. The off-gas decomposer shall be designed to destroy all residual ozone gas drawn from top of each fractionator for the initial build-out condition. The contact towers and fractionators shall be assumed to be zero-percent efficient in reducing the applied ozone

gas. Supplied as a complete integrated package, either cabinet, or skid, or wall mounted. Equip with U.L. certified electrical power disconnect switch, and status contact switch to interlock with ozone generator. The de-mister may be supplied separately.

3. De-mister: Constructed of ozone and saltwater spray resistant materials (Type 316 grade stainless steel or non-metallic construction); capable of removing foam and water particles damaging to the catalytic elements. Where installed outdoors, constructed of opaque U.V. resistant materials. Shall be oversize to preclude blow-thru of mist or liquids. Include drain trap where installed remote of ozone contactor.
4. Heater: The heater shall provide the minimum low temperature required by catalytic unit. Resistance-type, constructed of Type 316 stainless steel and controlled by an integrated circuit controller.
5. Catalytic Canister: Capable of converting 100% of the applied ozone gas at flow rates as scheduled on Drawing LS0.06. Shall be designed for an expected maximum pressure drop of 2-inches of water throughout first six months of operation. The unit shall not be "optimized" to operate at a temperature higher than 200 deg. F maximum. The unit shall have a maximum bed velocity number of 3,500 and a maximum face velocity or 1.5 ft./second; or a flow rate per volume of catalyst no greater than 20 SCFM per cubic foot; or a minimum empty bed contact time of 3.0 seconds.
6. Vacuum Gauges (two required or one differential pressure type): Bourdon Tube, dial faced, with 316 stainless steel bellows. Range shall be "zero to ten" inches of water pressure with smallest graduations of 0.25 inch. Locate gages on either side of the catalytic unit.
7. Blower: Current design and available upon request as a stock off the shelf item, as low speed RPM as possible, and equipped with ball bearings with external lubrication points. Located downstream of the heater and catalytic converter and designed for long life at high temperatures.
8. Materials: All corrosion resistant materials. Electrical box and electrical conduit shall be of non-metallic materials and all equipment shall be rated for outdoor use.
9. Miscellaneous: Inlet/outlet connections shall be flanged with 150 lb. drilling pattern.
10. Controls: Shall include termination for connection to the LSS ACS for relay of status condition.

C. Type “C”: Small Off-Gas Decomposers with Blower

1. Locations: For use for at dual containment ozone gas piping and installed in ozone generator rooms.
2. The off-gas decomposer shall be designed to destroy ozone gas drawn from dual containment piping in the case of an unexpected leak. The dual containment piping is dry and a demister is not required.
3. Heater: The heater shall provide the minimum low temperature required by catalytic unit.
4. Catalytic Canister: Capable of converting 100% of the applied ozone gas from the largest ozone generator in the piping system connected to the off-gas decomposer.
5. Blower: Capable of a producing a 10 to 45 SCFM flow rate in a free air flow situation and capable of running continuously with a zero air flow. Located downstream of the heater and catalytic converter and designed for long life at high temperatures. Provide a check valve to allow ambient air to be drawn into the suction of the blower as required.
6. Controls: Shall include termination for connection to the LSS ACS for relay of status condition.

2.6 AMBIENT OZONE MONITOR

A. Location: Low concentration ozone monitors located per drawings and equipment schedule.

B. Range 0 - 1 ppm, resolution 0.01 ppm, repeatability +/- 0.01 ppm. Monitors shall have a digital readout which displays the ozone concentration directly in ppm.

C. Monitors shall use a stable electrochemical gas sensor close-coupled to a digital transmitter.

D. Monitors shall be equipped with dry-contact interlock switches. All switches shall close when the ozone level exceeds an adjustable preset level. Switches shall not lock-out, but shall open when the ozone level falls below the adjustable preset level plus a dead-band control range. The interface with the ACS control panel will be 24VDC.

E. The alarm set point shall be adjustable via the instrument's software.

F. Monitors shall be microprocessor controlled with continuous internal diagnostics. When the diagnostics detect a fault with the monitor, all the dry-contact interlock switches shall close.

G. Instrument related errors or power failure shall be reported on the front panel display and equipped with a dry contact for external announcement of such errors.

H. Manufacturer: *Ozone Water Systems* (OWS); *Analytical Technology, Inc*. (A.T.I.), Oaks, PA.; or approved substitute.

2.7 EXTERNAL WARNING DEVICE

A. Locations: Mounted in visible locations outside entry doors rooms with ozone generation.

B. Supply a remotely mountable warning device which includes the following, at minimum: two flashing lamps (one amber-equipment failure, one red-ozone leak), horn (ozone leak, with acknowledgment button), and warning plaque all contained in a Nema 4X enclosure. Plaque shall have permanent contrasting lettering reading:

WARNING: OZONE GAS, A STRONG TOXIC OXIDANT
MAY BE PRESENT WHEN LAMP AND HORN ARE ACTIVATED

C. Power shall be supplied to the Warning Device from the Ambient Ozone Monitor. Supply with a reset switch to switch power off to warning lamp and horn. Switch shall automatically reset when dry contact on ambient monitor is closed. Provide test position or warning test switch.

D. Supply lamp, horn and plaque on a common base with fixture for wall mounting.

2.8 SAFETY EQUIPMENT CABNIET

A. Locations: Locate one fully stocked safety equipment cabinet outside the entrance of each room with ozone generation.

B. Cabinet for safety equipment: Provide a non-metallic NEMA 4X cabinet to contain safety equipment specified herein. Cabinet shall be wall mounted, gasketed, weather-tight, shelves/hangers for related equipment, glass front window, and non-locking handle.

C. Respirator Masks: Furnish in each cabinet two (2) half-faced respirator masks as follows: Of 100% silicone rubber, medium size with replaceable purifying cartridges and with NIOSH/MSHA approvals. Provide one extra headband for each mask. Provide with each mask a box of six (6) replacement cartridges listed for the removal of ozone gas (white type K, acid gas). Silicone half-face mask and accessories by Pro-Tech or approved substitute.

D. Personal Sensors: Furnish in each cabinet: one (1) portable personal type sensor manufactured specifically for detection of ozone gas. The monitors shall visually alert personnel of conditions that exceed the current OSHA 15 minute Permissible Exposure Limit (PEL) with either a flashing lamp, or bar graph, or audible alarm or digital readout. Include battery charger, carrying case and calibration equipment as required, by one of the following manufacturers: Eco Sensors www.ecosensors.com; ENMET Corporation www.enmet.com; O3 Company; ATI Analytical Technology, Inc.; or approved substitute.

E. Monitor Badges: Furnish six (6) clip-on personal diffusion type monitors manufactured specifically for detection of ozone gas. The monitors shall visually alert personnel of conditions that exceed the current OSHA 15 minute Permissible Exposure Limit (PEL).

F. Provide information on health and safety for operation of ozone generators and related equipment.

2.9 SIGNAGE

A. At each ozone generator room, and off-gas decomposer location, provided an engraved plastic plaque with permanent contrasting lettering reading:

WARNING: OZONE GAS, A STRONG TOXIC OXIDANT

PART 3 - EXECUTION (See Section 170010)

3.1 INSTALLATION & START-UP SERVICES BY EQUIPMENT SUPPLIER

A. The ozone systems equipment supplier shall provide technical assistance to on-site contractors of related trades, field visits for supervision of the installation, and an Owner Technical Training Seminar, as specified above and as required of fully functioning ozone generating systems.

B. When on site, the ozone systems technician shall provide written startup, shutdown, and routine operations procedures covering both standard operations and special operations encountered at the time of start-up. Prior to leaving the site, the technician shall provide written documentation signing-off on the status of all equipment and functionality of the projects ozone systems.

3.2 INSTALLATION BY CONTRACTOR

A. General: Install all the equipment as recommended by the manufacturer, specified and shown on the drawings in a neat and orderly manner to result in a complete, safe and functional system.

B. If an Alternate Manufacture is selected by the Contractor, make all necessary modifications for a complete functional system including, mounting requirements, piping changes, additional valves, modified electrical power supply, and other required changes for a complete installation.

C. Contractor shall ensure electrical equipment is in conformance with a approved testing laboratory listing and bears certification labeling.

D. Mounting: Provide housekeeping pads where required for skid/base mounted equipment. Mount safety equipment storage cabinet outside each ozone generator room.

E. Connections: Make all connections necessary to complete the process indicated on the contract drawings or otherwise required by the manufacturers shop drawings; the primary connections are generally as follows:

1. Air Prep Equipment: Electrical power, interlock wiring, make connection at compressor with braided stainless steel hose, use copper piping for air line. Connect inlet to air receiver tank on side near bottom with outlet at top. Install automatic condensate drain at bottom and route discharge to oil/water separator. Optionally, Contractor may arrange for control wiring to be installed by the ozone equipment vendor.
2. Ambient Monitor and Warning Alarm: Provide interlock connections. Power shall be provided with connection to the control panel of the ozone generator.
3. Off-Gas Decomposers: Electrical power, interlock wiring, and piping (ducting) connections. Provide condensate drain piping from the de-mister and other low points in the off-gas piping and route to floor drains with gas traps.

4. Auto Condensate Drains: Provide electrical power. Route discharges to condensate management system or floor drain.
5. HVAC Interconnect: Connect wiring to the building HVAC system to verify operation of operational exhaust system for the ozone generator room.

F. Warning Annunciator: Mount warning plaque, horn, and flashing lamp above entry to ozone room and complete wiring to ambient ozone monitor.

G. Safety Cabinet: Mount safety equipment cabinet in appropriate location, stock with specified gear, and sign-off on delivery of safety equipment with Owner's Representative.

H. Transmission Piping: Install ozone gas tubing, fittings, valves and off-gas duct-work as specified in Section 170261.

I. Backflow Prevention: Contractor shall check to make sure the following process water backflow prevention measures have been taken:

1. Ozone generator equipped with normally closed valve on ozone out line (provided with packaged equipment).
2. Check valve on ozone out line (provided with packaged equipment).
3. Active backflow prevention device (provided with packaged equipment).
4. High loop in the ozone supply line, with drain plugs at low points.
5. Check valve(s) in ozone supply line near dosing end point (provided by Contractor, valve per spec Section 170155).
6. Mazzei injector equipped with manufacturer's standard check valve option (see spec Section 170288).

J. Pressure Regulation: Adjust pressure regulators at each ozone generator to meet requirements of various equipment operating on the same pressurized air supply.

END OF SECTION

SECTION 170753 - CALCIUM REACTORS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. The Calcium Reactors are intended for maintaining calcium and alkalinity after calcium is added by the operational staff to achieve the desired base calcium concentration.

B. Project includes calcium reactors as scheduled on the Drawings.

C. Manufacturer shall provide all components necessary for operation, in a pre-engineered package, compatible with the seawater system and facilities provided. The package of equipment shall be completely self-supporting.

D. Capacity and Sizes:

1. Flow Rate: Designed to operate with a rangeable water flow. The incoming/effluent water flow rate may be adjusted from the flow rate specified above as recommended by the manufacturer of the calcium reactor.
2. Recirculation Rate: Each reactor shall have a factory-supplied recirculation pump. The recirculation water flow rate shall be as recommended by the manufacturer of the calcium reactor.
3. Reaction Chamber: Clear acrylic reaction chamber, sized by manufacturer. See Reactor Schedule on the Drawings for preliminary sizing.
4. Secondary Chamber: Clear acrylic reaction chamber sized by manufacturer. Filled with calcium carbonate media, for the purpose of improving the calcium and alkalinity saturation and increasing the pH.

E. Individual electrical components shall be in conformance with all local, State of North Carolina and Federal codes, statutes and ordinances where they apply, including required listing by testing authorities.

F. Provide all wiring complete with packaged equipment, including all junction boxes and transformers as required, for a single point of connection for 120 VAC power supply. All wiring shall be completed with the factory shipment or by the manufacturer’s factory representative during the on-site Technical Seminar.

G. Each Calcium Reactor shall be mounted on a non-metallic corrosion-resistant base, including carbon dioxide proof tubing for the discharge and drain lines. The CO2 pressure tank(s) shall be separate from the Calcium Reactor skids.

H. The manufacturer shall provide an on-site Technical Seminar for final setup and demonstration of proper operations to the Aquarium’s operational staff.

1.2 SUBMITTALS

A. Submittal manufacturer’s product information, including all components, bill of materials, dimensions, electrical requirements, installation recommendations, capacities and quantities. Use equipment tags from the LSS drawings to indicate items being submitted. Verify quantities and capacities as given on the drawings.

B. Submit verification of on-site Technical Seminar by factory representative and a brief description of activities when on site.

C. Submit warranty covering all equipment a guarantee for drip-tight operation at 20 psi water pressure minimum.

1.3 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010, including recommendations for maintenance prior to putting in service.

1.4 COORDINATION

A. Contractor shall coordinate installation with the electrical drawings and specifications. Including wiring, conduits, breakers and switches, relays and other power supply and control devices.

B. Contractor shall be responsible for assembly of items shipped separately. Any final adjustments, including required materials, shall be completed by the factory representative at the time of the Technical Seminar.

C. The Contractor shall complete the installation of Carbon Dioxide Monitors, with connection to the Automated Controls System (ACS), along with local visual and audible alarms. Installation of dedicated Carbon Dioxide Monitor is required as where CO2 cylinders are in-use or stored.

D. Contractor shall provide the initial CO2 gas cylinder for startup of the system. May be obtained from a local reputable welding gas supplier if not supplied by the manufacturer of the Calcium Reactors.

E. Manufacturer of the Calcium Reactor shall check the water feed flow rate on the Drawings and verify sufficient flow is available.

F. If 3-phase 120 VAC power is required, the proper electrical power wiring shall be installed by the Contractor.

1.5 WARRANTY & GUARANTEE

A. Manufacturer shall warranty all parts and performance of the system for no less than 2-years following the date of receiving shipment. The acrylic chambers, covers, and adjoining parts shall be guaranteed for dry drip-proof operation with 20-psi minimum water pressure.

1.08 PACKAGED EQUIPMENT MANUFACTURER/SUPPLIER

A. Base Manufacturer: The following manufacturer has standard off-the-shelf units meeting this specification:

1. *My Reef Creations*, Lawrenceville, GA www.myreefcreations.com contact Raj at (678) 407-3773.

B. Alternate Manufacturers: The following manufacturers may or may not have products available for meeting specified requirements:

1. *Integrated Aqua Systems* (760) 745-2201 www.integrated-aqua.com;
2. *Korallin*;
3. *Reef Octopus*, Slidell, Louisiana, telephone (507) 304-2579, www.reefoctopus.com.

PART 2 - PRODUCTS

2.1 CALCIUM REACTOR(S)

A. Shall be designed to deliver calcium and alkalinity to promote growth of stony corals and clams. Each unit shall include a large reaction chamber and secondary chambers to increase buffering and dissolution capability.

B. All specified equipment, meeting the specified performance requirements, shall be provided as a single component package mounted on a non-metallic corrosion resistant base.

1. Materials: All components, including fasteners, shall be of Type 316 stainless steel or better, non-metallic materials, clear acrylic, Sch 40 PVC piping, CO2 compatible materials where applicable, and otherwise built for installation in a saltwater aquarium. Use of ferrous metal materials shall not be incorporated in any components of the saltwater process. Bronze may be used for gas regulating valves.
2. Electrical: The package shall be delivered complete with electrical wiring, conduits, fastenings, junction boxes, and transformers for a single-point of connection to a 120 VAC power source. All electrical wiring shall be Code compliant and compliant with local electrical regulations.
3. Piping and Tubing: Rigid water piping shall be Sch 40 PVC. Plastic tubing, of *Tygon* or equal, may be used for small water flow and union connectors and stop valves by *John Guest*, or equal. Tubing used for CO2 gas shall be as recommended by the tubing manufacture for use with CO2 gas.

C. Media Chambers: Each Calcium Reactor skid, shall be provided with two (2) or three (3) chambers as follows:

1. Reactor Chamber(s): One (1) or two (2) main calcium reactor chambers built for recirculation of water through calcium media for the purpose of dissolving the calcium media. Constructed of a clear acrylic tube not less than 0.375-inch thickness. Components in the profile of the up-flow reactor shall be as follows:
    a) Top access cover with vent fittings as required.
    b) Outlet to recirculation pump suction with gas/bubble release device.
    d) Space for recommended volume of calcium media.
    f) Perforated water distribution plate or center spray-bar pipe.
    g) Piping at the bottom of the reactor arranged for distribution of recirculating water.
2. Secondary Chamber: Clear acrylic tube not less than 0.25-inch thickness for processing of the final effluent water, filled with calcium media, for the purpose of improving the calcium and alkalinity saturation and increasing the pH.
3. Chamber Construction: Chambers constructed with a clear vertical tube with a full-diameter flanged end on top for access. Flange thickness shall be as required to prevent any buckling and be drip-tight. Top covers secured with key-hole screw hasps, or metallic lock-levers, for ease of securing the top cover. Provided O-rings in grooves built into the flange of the chamber below the top plate.
4. Drip-Tight Construction: Acrylic reactors shall be constructed and guaranteed not to leak at pressures up to 20 psi, although actual operational pressures are expected to be less than 20-psi.

D. Skid Base: Provide with a skid base with mounting lugs for bolting to the floor, constructed of Type 316 stainless steel and/or non-metallic components.

E. Gas Tubing: Tubing compatible with CO2 gas and equipped with union connectors and stop valves by *John Guest*, or equal.

F. Two-Stage Gas Pressure Regulator: Designed for reducing the high-pressure CO2 gas, with a constant lower pressure at the outlet. Equipped with a spring, diaphragms, and adjustment knobs. Shall be a two-stage regulator, with the first stage reducing pressure to approximately 90 psi, and the second stage reducing gas pressure to 0 to 15 psi. Bronze body and internal materials compatible with CO2 gas. By *Harris* www.harrisproductsgroup.com or equal.

G. Regulator Connector: Bronze regulator connector, for *Compressed Gas Association* (CGA) Type 320. With no less than 12 extra use-once flat washers, or *Teflon* gaskets, provided to the Owner.

H. Needle Valve: Body and stem constructed of Type 316 stainless steel with Teflon packing and sized for fine adjustment of the CO2 gas.

I. Check Valve: Body and stem of Type 316 SS and located to prevent backflow of saltwater between the CO2 gas pressure regulator and the reactor.

J. Effluent Out Valve: Diaphragm type valve for adjustment of small water flow going out back to the LSS, by *ASAHI America,* substitute valve selected by manufacture of Calcium Reactor.

K. Water Flow Meters: Installed in the reactor recirculation pump discharge piping and installed in the final saltwater effluent piping. Variable area float meters, also known as rotameters. By *Blue-White Industries* Westminster, www.bluwhite.com; *Gilmont Instruments* www.barnant.com; or *King Instruments* www.kinginstrumentc.com; no substitutes.

L. Bubble Counter or Carbon Doser: Bubble counter or electric valve that generates on one portion carbon gas bubble every 0.1 to 10 seconds. Rheostat knob for CO2 control. Equipped with power supply, tubing, and non-return valve. By *TUNZE Aquatic Eco Engineering* or bubble counter selected by manufacturer.

M. Mixing Chamber: As may be required, clear chamber for mixing of feed water with CO2 gas from the Carbon Doser or bubble counter.

N. Calcium Media: A natural product specifically recommended by the manufacturer of the calcium reactor(s) for stony coral aquarium use. Consisting of relatively uniform size coral bones harvested from a sustainable source in the Western Pacific Ocean. Also known as aragonite pebbles from fossil corals. Shall be legally sourced.

1. Size: Coarse size. Coral bones larger than 1 cm are preferred. Package shall be free of fine coral sand.
2. Cleanliness: Washed in RO water to eliminate dust and have very low fines as well as manual removal of any snail or clam shells before packaging.
3. Dissolution: Shall completely dissolve over time in the calcium reactor.
4. Product Name: “Reborn Calcium Reactor Media”
5. Suppliers: *Bulk Reef Supply*, telephone (763) 432-9691 www.bulkreefsupply.com; *My Reef Creations*, Lawrenceville, GA www.myreefcreations.com contact Raj at (678) 407-3773; or Approved Substitute.

O. Carbon Dioxide Monitors: Wall-mounted ambient CO2 gas monitors, with alarm, for protection of aquarium staff personnel against excessive CO2 gas in the environment. Must be

recommended by the manufacture for personnel breathing safety. Accuracy of +/- 100 ppm CO2, or lower value, at the installed detection range. Equipped with a visual alarm display and an auditory alarm. 4-20 mA output for connection to the Automated Controls System (ACS). Provided with a 120 VAC to 24 VDC transformer power supply as required. May be mounted with the equipment skid or installed separately as a wall-mounted unit. By *Honeywell*, *ATI*, *Sensaphone*, or approved substitute.

P. Pressurized CO2 Cylinders: Sizes recommend by the manufacture of calcium reactors. Commercial grade pressurized liquid CO2, in 1,800 psi cylinders, from of reputable source, such as a welding gas supplier, or www.beveragelements.com. May be delivered at time of Technical Seminar.

Q. Recirculation Pump: Recirculation pump as recommended by manufacture of the Calcium Reactor. Equipped with a Variable Frequency Drive (VFD) if recommended by the manufacturer. Must be 120 VAC, single phase, powered.

R. Bleed Valve: Provide either a process for remixing gas that accumulates in the reactor chamber or a bleed valve. Bleed valve may be a Type 591 by *Georg Fischer*.

S. Solenoid Valve: Included if recommended by the manufacturer of the calcium reactor.

T. pH Controller: Each reactor unit shall include a pH probe/controller, probe holder with piping, wiring, and hardware/software programming.

PART 3 - EXECUTION

3.1 INSTALLATION AND SET-UP

D. Install all equipment as recommended by the manufacturer, specified and as shown on the Drawings in a neat and orderly manner to result in a complete, safe, and functional system. Install PVC true-union connections with a grease lubricant to keep them from freezing up from the excess calcium in the water.

E. CO2 cylinder(s) shall be installed as close to each reactor as possible.

F. Take precautions as recommended by manufacturer of the Carbon Doser, or bubble counter, when operating CO2 gas valves.

G. CO2 cylinders shall not be installed or stored at indoor or enclosed location before proof of and operational and calibrated ambient CO2 gas monitor.

H. Fill the reaction and secondary chambers, to within 1.5-inch of the top, with specified media.

I. Install the bubble counter as recommended by the manufacture.

A. Contractor shall coordinate a “Technical Seminar” presented by manufacturer’s technical representative to the Owner’s maintenance and operations staff. Verify delivery of no less than 12 extra use-once flat washers, or *Teflon* gaskets, for connection to the pressure regulator.

END OF SECTION

SECTION 170774 - ULTRAVIOLET STERILIZERS

PART 1 - GENERAL

1.1 USAGE

A. The ultraviolet sterilizers are used in 35 to 95 deg F fresh and saltwater.

1.2 REQUIREMENTS

A. Submittals shall be in accordance with procedures set forth in Section 170010.

B. Provide in quantities and capacities as given on the drawings.

C. Electrical equipment shall be in conformance with all local, State of North Carolina, and Federal codes, statutes and ordinances where they apply, including required listing by testing authorities. Acceptable listing authorities include Underwriters Laboratory (UL), International Organization for Standardization (ISO), American National Standards Institute (ANSI), Canadian Standards Association (CSA), and Edison Testing Laboratories (ETL). The manufacturer shall be fully responsible for compliance with this requirement. If field approval is necessary to meet listing requirements, it shall be completed without delay to the project and at no additional cost to the Owner.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: The manufacturer shall have at least 20-years of experience in the manufacture of similar items with a record of successful installations.

B. The manufacturer shall be ISO;9001 certified.

1.4 COORDINATION

A. Verify all electrical, life support and other trades requiring that interface with the sterilizer.

B. Coordinate cooling requirement of unit with ventilation of enclosure.

C. Do not install electronic monitors, such as water flow sensors, or ORP transmitters, withing 15-foot of U.V. lamps or the U.V. ballast/controller.

D. Contractor to verify, prior to ordering, if extended cable lengths between control box and UV vessel are required compared to standard (approximate 15 ft) cable length.

1.5 SUBMITTALS

A. Submit dimensions of all components, capacities, bill of materials, electrical requirements, and installation recommendations.

B. Submit literature/data from the manufacturer of the lamps.

C. Warranty: Guarantee all equipment furnished under this Section against defective parts and workmanship covering 100% parts and labor for a minimum of two years from the date of delivery.

D. Submit warrantee and affirmation of warranty period as specified below.

1.6 WARRANTY

A. The manufacture shall warranty all components to be free of defects in material and workmanship for 2-years after startup in the water treatment system, or 2-years after Owner acceptance of the units from the installing Contractor, whichever is less – excluding consumables, such as lamps and O-rings. Lamps warranty to be prorated based on service time before failure.

1.7 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010.

PART 2 - PRODUCTS

2.1 DESIGN AND PERFORMANCE

A. The geometry shall be of a compact arrangement of the UV lamps, and water ports, allowing for installation and maintenance within the limited available space at the project site. Vessel configurations shall be a U-type configuration, or *SITA* Z-type configuration as shown on project drawings.

B. Lamps shall be high efficiency low pressure amalgam – 200W for small units, 440W for large.

C. Basic performance rating shall be greater than 99.9 percent bacterial reduction across the sterilizer. The UV transmissivity (UVT) of the water shall be assumed to be 90% for the purposes of design.

D. Units shall conform to the requirements listed in the equipment schedule shown on the drawings. At end of lamp life with a minimum UVT of 90% at rated water flow rates, the sterilizers shall deliver a minimum light intensity of:

1. 30,000 micro-watts-sec per square centimeter for recirculated aquatic animal systems.
2. 40,000 micro-watts-sec per square centimeter, for human contact / interaction (“Touch”) tanks, such as TOU system with touch pools.
3. Performance at flow shall be validated via CFD analysis.

E. Pressure drop across the sterilizer, from inlet to outlet, shall be no greater than 2-psi when operated at the specified intensity. Pressure drop at design flow shall be confirmed by the manufacturer via CFD analysis.

F. Vessel shall have a max pressure of 75 PSI minimum.

G. Temperature limitations are from 35 °F to 95° F process water temperatures at ambient air temperatures from 41 °F to 113 °F. Unit shall include high temperature protection resulting in power cut-out on high temperature with a lock out for manual re-set.

H. Water flow pattern shall have proven performance to create sufficient turbulence to assume full exposure to ultraviolet rays.

I. UV Sterilizers shall have flanged port size, with ANSI 125/150 lb. bolt pattern, as indicated on the Drawings.

J. Equip with controller separate of the UV bulb/water contacting housing for ballast starting of the lamps.

K. Minimum lamp life, with at least 85% output, under the specific design ratings shall be no less than 16,000 hours for 440W lamps and 14,000 hours for 200W lamps.

L. The units shall not require flowing fluid to prevent overheating.

M. Vertical or Horizontal Lamp Orientation:

1. Small *SITA* unit (200w lamps) can be mounted vertically or horizontally.
2. Large *SITA* units (440w lamps) to be mounted horizontally.

N. Support Legs: Shall have HDPE legs included with dimensions matching the installation as shown in the Drawings as required.

O. Provided transformers shall not generate EMI disturbances. Include required transformer to site's 120V power as necessary. Provided transformers shall not generate EMI disturbances.

2.2 MATERIALS

A. Lamp sleeves shall be quartz glass specifically designed for transmission of U.V. light. Shall have tool-free design for maintenance of lamp and quartz sleeve.

B. All wetted components shall be corrosion free materials.

1. The UV vessel housing shall be constructed of heavy-duty carbon black polyethylene (HDPE). Joints shall be welded and not glued.

C. Cabinet and hardware for ballast/transformer/controller (not exposed to process water) shall be sealed NEMA4X plastic with passive heat dissipation without need for ambient air exchange.

2.3 ELECTRICAL AND INSTRUMENTATION

A. Basic ECOLINE/RACK LCD controller.

1. Control box to have LCD HMI screen with push button navigation, resettable lamp life hour meter, vessel temperature display, UV intensity display, and alarm LED.
2. Shall have individual LED displays provided for indication of lamp operation.
3. Remote on/off contact.
4. On/off timer.
5. UV vessel shall have temperature sensor and UV-C sensor.
6. Dry contact NO/NC for general alarm (2 amp max.)

2.4 MANUFACTURER

A. Base Model & Manufacturer: *SITA UV,* Distributed by *Integrated Aqua Systems, Inc. ,* www, integrated-aqua.com Vista, CA, telephone (760) 745-2201.

B. Alternate Manufacturers: This listing of potential manufacturers shall not compromise the above specified requirements and may require the Contactor to make adjustments in pipe routing from what is shown on the Drawings. The Contractor's selection of Alternate UV Sterilizers will require coordination of space for the physical unit and bulb removal clearance, as well as coordination for alternate electrical power requirements. Any required changes to accommodate an alternate is the Contractor's responsibility. Potential alternate manufactures, who may not have off-the-shelf size units as listed on the Contract Drawings, include the following:

1. Albright Ultraviolet, LLC. Cheyenne, WY (307) 316-2622 www.albrightuv.com;
2. approved substitutes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment as recommended by the manufacturer, specified and shown on the drawings in a neat and orderly manner to result in a complete, safe and functional system.

B. Do not install electronic monitors, such as water flow sensors, or ORP transmitters, withing 15-foot of U.V. lamps or the U.V. ballast/controller.

C. Set level and secure along lines established on contract drawings or as revised by approved shop drawings.

D. Mount Ballast Box on wall or mounting stanchion (if delivered with remote electrical enclosure) with instrumentation panel clearly visible from maintenance space.

E. Complete installation of power cables, from the ballast to the UV housings, in a neat and orderly manner, using cable trays or other support for a uniform and secure finish.

F. Contractor shall startup and verify operational functionality of ultraviolet sterilizers.

END OF SECTION

SECTION 170786 - REVERSE OSMOSIS DE-IONIZATION SYSTEM AND WATER SOFTENER

PART 1 - GENERAL

1.1 USAGE

A. The system is used, for treatment of potable water, to deliver RODI membrane filtered water to a storage tank for make-up of water for aquatic animals with high sensitivity to toxins and other unwanted compounds in the water.

1.2 SUMMARY

A. Packaged Delivery: The pretreatment water softener and reverse osmosis equipment shall be delivered by the same supplier and it is the responsibility of the supplier to ensure that both systems work in concert with each other.

B. Capacity: The RODI system shall be designed to meet the performance criteria identified on the equipment schedule on the contract drawings — a delivery of 3,000 gpd R.O. Product Water. Contractor shall verify flow rate with capacity Scheduled on Drawing.

C. Carbon Filtration: Pretreatment of the source water includes GAC filtration occurs upstream of this system and is not required with the delivery of the RO equipment in this specification.

D. Pretreatment Water Softener: Provide a vertical pressure type water softener system with pressure vessel, softening resin, control valve, brine maker, and controller as indicated on the drawings and as specified.

E. Reverse Osmosis (RO) System: Work includes furnishing and installing a complete packaged RO system including all necessary appurtenances to provide a complete operational system.

F. With De-ionization system cylinders.

G. Source Water: The source of water is from surface and groundwater sources as delivered by the City of Syracuse municipal water supply and is carbon media filtered before delivery to the Pretreatment Water Softener.

1. Water Pressure: 40 psi minimum
2. Water Temperature: 60 to 90 degrees Fahrenheit
3. Fluoride: 0.99 ppm maximum
4. Nitrate: 0.45 ppm nominal
5. Turbidity: 0.5 NTU maximum
6. Free Chlorine: 1.76 mg/L (before GAC filtration)
7. Chloramines: Unknown
8. Copper: 0.297 ppm maximum
9. Chloride: 26 ppm nominal (RO System shall be designed for 500 ppm maximum chloride concentration)
10. Iron: Unknown, supplier to verify prior to fabrication.
11. Manganese: Unknown, supplier to verify prior to fabrication.
12. pH: 7.3 to 8.6
13. TDS: 320 ppm maximum
14. TOC: 2.6 ppm maximum
15. Total Hardness as CaCO3: 390 ppm maximum.

H. The above parameters are before carbon filtration.

I. Verify Parameters: The delivered equipment shall perform at required for the parameters given above, which are maximums, or for a current “Water Quality Report” published by the City of Syracuse, New York, Public Water Works for water delivered to Onondaga Aquarium project site.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: The RO supplier shall have at least 10-years experience in the manufacture of similar items with a record of successful installations. RO supplier shall have a local service center within 50 miles of the Aquarium.

B. Design Requirements: Design shall comply with these Specifications and all OSHA and local safety codes.

C. Testing Laboratory Requirements: Acceptable qualified testing laboratories shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) for Labels on Electrical & Mechanical Equipment. Acceptable listing agencies include Canadian Standards Association (CSA), Intertek Testing Services ITS-ETL, and Underwriters Laboratory (UL). Depending on the “Equipment Category” other testing agencies may be qualified by the State of North Carolina; such as NSF International and other approved research laboratories. The manufacturer shall be fully responsible for compliance with this requirement. If field approval is necessary to meet listing requirements, it shall be completed without delay to the project and at no additional cost to the Owner.

D. The systems shall be fully tested at the factory and only require simple utility connections (feed water inlet, product water outlet, drain and power).

1.4 SUBMITTALS

A. Pretreatment Water Softening: Catalog cuts and sufficient data including flow rates, pressure drops, dimensions, weight, resin data, and material schedule.

B. RODI Equipment: Submit fully detailed shop drawings of the skid mounted RO system. Including complete assembly, anchorage, and installation drawings, together with detailed specifications and data covering materials used, parts, wiring, devices, and other accessories forming a part of the equipment furnished. Include technical information from manufacturers of all sub-components.

C. Where Contractor selects an alternate manufacturer from the listed Base Supplier, the Contractor shall list all modifications required for the alternate product to match the Contract Drawings including Shop Drawings of the alternate product with the Submittal.

D. Submit proof that installed materials will bear approved testing agency listing mark or classification markings.

E. Submit narrative on possible need for acid re-adjustment equipment and other system specific or non-specified equipment.

F. Submit factory warranty of all equipment.

G. Submit description of start-up services by the factory representative.

H. O & M Manual: Prior to acceptance of the system by the Owner, submit operation and maintenance manual covering the following items:

1. Piping & Instrumentation (P&I) diagram of packaged system.
2. Single line electrical drawing of power distribution.
3. Electrical control schematics cross referenced to PLC programming.
4. Operator interface listing and commentary.
5. General arrangement drawings.
6. List of components cross referenced to the P&I diagram and the electrical diagram(s).
7. Description of operations for commissioning, normal start-up, normal shutdown, cleaning, and storage set-up.
8. Suggested listing for collection of data and reporting to allow proper review of system performance.
9. Vendor brochures and manuals for major components.

1.5 COORDINATION

A. Coordinate power supply between selected equipment and the electrical design. Electrical contractor to provide fused disconnect switch within 5-ft. of installation.

B. Coordinate the order for “horizontal” or “vertical” RO membrane tubes at the time of the order.

1.6 WARRANTEE

A. The manufacture shall warranty the entire package assembly to be free of defects in material and workmanship for 1-years after Substantial Completion. The manufacture shall replace any components found defective within the warranty period.

1.7 FACTORY START-UP ASSISTANCE

A. Technical Start-Up: Supplier shall provide a minimum of two (2) working days, of factory trained technician to assist in the installation and start-up, and to inspect, calibrate and start-up the equipment. Shall include field-verification of all automated and programmed functions.

1.8 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010.

PART 2 - PRODUCTS

2.1 PRETREATMENT CARBON FILTRATION

A. The effluent, from carbon filtration associated with the LSS FWMU system, is anticipated to deliver water with less than 0.02 ppm free chlorine to the RODI package.

2.2 PRETREATMENT WATER SOFTENING

A. The pretreatment water softening system shall be delivered with the packaged RO System to protect the RO System from damage by contaminants in the source water. Shall have a maximum pressure drop of 15-psi across the softener vessel.

B. The effluent water hardness shall be 10 mg/l maximum and otherwise provide water in compliance at all times with requirements the RO System. The system shall not include a bypass for hard-water to be delivered to the RO System.

C. The softener system shall include duplex alternating softener tanks and one brine tank.

D. Resin Exchange Tank: The tank for exchange resins shall be a non-metallic composite vessel rated for 100 psi working pressure. The tank shall be equipped with an opening for media filling and periodic inspection.

1. Internal Distribution: The upper distribution system shall be designed to distribute water to the resin media without creating channeling.
2. Main Operating Valve: The system shall have a main operating valve mounted on top of the softening vessel. The valve shall have multi-positions to accomplish all operational steps, motor driven, piston type to positively locate the internal valve piston to route the flow of water through the softener during service, backwash, brine draw/rinse, and fast rinse/brine refill. The internal piston and seal assembly shall be of a modular cartridge design for ease of replacement and service.

E. Brine System: Provide a brine tank and related gear for completion of the pretreatment and RO process. Including a plastic tank, distribution clack traps, all required piping and fittings, and FRP strut where required for field mounting. All fasteners shall be Type 316 stainless steel. The valve for brine injection shall automatically open for eduction of brine into the softener tank, close to prevent suction of air, and allow the brine tank to be refilled with the proper amount of water. Supplier to provide initial load of salt for brine tank.

F. Softener Controls: Control function shall be performed by a programmable logic controller (PLC).

1. The softener shall regenerate based on either the volume of water treated or time and initiate as programmed. The main operating valve shall be controlled by volume-initiated regeneration. The controls shall perform the regeneration functions on the exhausted tank and return it to the service position.
2. A recharge lever, or control functions, shall be provided to permit manual regeneration initiation at any time.
3. The system shall account for routine brine injection as required.

G. Electrical Power: Shall be powered by a single 120 VAC power cable per softener vessel/controller.

H. Exchange Resin: The unit shall be supplied with 3.0 CF/gpm, cubic foot of virgin high capacity standard mesh of sulfonated polystyrene type cation exchange C-211 resin stable over the entire pH range (7.3 to 8.6 pH units) with good resistance to bead fracture from attrition or osmotic shock. Each cubic foot of resin shall be capable of removing 30,000 grains of hardness as calcium carbonate when regenerated with salt. The resin shall be manufactured to comply with the food additive regulation 21 CFR 173.25 as set forth by the USFDA. Additionally, a layer of support gravel shall be provided.

I. Flow Meters: Flow meters shall be provided to totalize the flow, initiate regeneration, and to monitor the flow rate.

2.3 RO SYSTEM

A. Skid Frame and Fasteners: The complete system shall be mounted on a steel frame with a durable corrosion protection coating. Fasteners shall be Type 316 stainless steel.

B. Booster Pump: Single-motored high-pressure vertical pump of Type 304 or superior stainless steel, and non-metallic composite materials. The motor shall be TEFC and close-coupled. Shall include the motor starter housed in a NEMA-4X enclosure.

C. Prefilter or Polishing Filter: Include either a 5-micron dual gradient polypropylene prefilter ahead of the Booster Pump, and/or a non-metallic housed cartridge polishing filter after the Booster Pump.

D. Throttling Valve: Equip the pump discharge line with an appropriately size valve designed specifically for high differential pressure throttling of flow.

E. Piping: Flexible PTFE hose with external braided stainless steel reinforcement, Schedule 80 PVC for low-pressure piping, cross linked polyethylene (PEX) tubing, Type 316 stainless steel for all high pressure piping. All piping materials to be selected by the manufacturer for best use.

F. Valves: Stainless steel construction. Sample valve shall be located on each pressure vessel and the product line for sampling of water quality.

G. Pressure Vessels: The spiral wound FRP pressure vessels, with polypropylene end caps, and FNPT fittings for installation of RO elements.

H. RO Elements: Horizontally or vertically oriented based on the Contractor order, spiral wound thin- film polyamide, ultra- low energy brackish water RO elements. For treatment of feed water with a maximum chloride concentration of 300 ppm. For ease of operator handling, the RO elements shall have a maximum length of 48-inches. Membrane elements shall have a flux less than 10 gpd/ft^2.

I. Pressure Gauges: Stainless steel housing with 2.5-inch dial, Type 316 bourdon tube, and liquid filled. Provide pressure ranges suitable for the operating conditions. Installed at the following locations:

1. Raw water inlet.
2. RO pump suction.
3. RO pump discharge.
4. RO pump throttling valve.
5. Product water outlet.
6. Reject water outlet.

J. Instrumentation: Equip with instrumentation for monitoring of all routine functions.

1. Pressure gauge (at above locations).
2. Low Feed Pressure Switch & High Pump Pressure Discharge Switch.
3. Feed Water Conductivity Sensor: Type 316 SS housing. 0-2,000 µS/cm range, temperature compensated, with digital display.

4. Product Water Conductivity Sensor: Type 316 SS housing. 0-2,000 µS/cm range, temperature compensated, with digital display.
5. Flow Indicators: For product water flow, reject water flow, and recirculation water flow.

K. Controller: Microprocessor, with LCD screen or superior HMI, for management of all routine operations and communication with the LSS ACS via ModBus TCP/IP protocol with RJ-45 connection. Shall include an audible alarm with a red alarm lamp.

1. Warning Messages:

a. High TDS/Conductivity
b. Chemical Tank Low
c. Operating Hours Exceeded

2. Shutdown Alarms:

a. High TDS / Conductivity
b. Pressure Fault. The RO shall attempt to restart upon pressure fault and shall shut down once the maximum number of restarts has been exceeded.
c. High Feed Temperature
d. Pretreatment Lockout (non-alarming, start and stop condition)
e. Storage Tank Full (non-alarming, start and stop condition)

3. Status Indications:

a. High TDS / Conductivity
b. Pressure Fault (Low Feed and/or High Membrane Feed)
c. High Feed Temperature
d. Pretreatment Lockout (non-alarming start and stop condition)
e. Storage Tank Full (non-alarming start and stop condition)
f. Operating Hours
g. Operating Status (Standby, Operating, Tank Full, Pretreat, Membrane Flush)

4. Auxiliary Relays: Two (2) 120 VAC, 5 Amp minimum, relays.

L. Electrical: Shall be configured to receive power from a single 120 VAC 1-phase power cable with all requirements to lower power components of the system provided with the unit. Power supply to the skid shall be furnished and installed by the Contract 3B. Provide all necessary power transformation from single-phase supply, relays, motor starters, and circuit protection. Equipped with a single main disconnect switch designed for lock-out/tag-out. All wiring shall be in rigid corrosion-resistant conduit.

2.4 DE-IONIZED (D.I.) CYLINDERS

A. Flow and Capacity: Shall deliver a minimum water flow of 0.25 gpm with an expected water use of 15 gallons per day or as required.

B. Number and Size: Three 8” diameter by 20.5” high D.I. cylinders or as required.

C. Provide a pre-filtration cartridge filter if the cylinder service provider determines the requirement for the given water source.

D. Three (3) filtration cylinders shall provide demineralization of domestic water:

1. Cylinder with granular activated carbon (GAC) media.
2. Cylinder with resin beads for removal of cation ions.
3. Cylinder with resin beads for removal of anion ions

2.5 EQUIPMENT SUPPLIER

A. All equipment specified herein shall be supplied a single supplier.

B. Base Suppliers:

1. *Evoqua Water Technologies LLC* (518) 256-9225, contact David Flood, email david.flood@xylem.com; 6713 Collamer Road, East Syracuse, NY 13057

C. Alternate Suppliers: The Contractor may optionally suggest an Alternate. This listing of potential manufacturers shall not compromise the above specified requirements and may require the Contactor to make adjustments in power supply, equipment layout, and pipe routing from what is shown on the Drawings. Potential alternate manufactures include the following:

1. Pure Aqua www.pureaqua.com telephone (714) 432-9996, contact May Higazy, may@pureaqua.com;
2. Water Works Ultrapure Solutions San Diego, CA (858) 499-0119.
3. Lakeside Water Treatment, Inc., email: info@lakesidewater.com phone: (414) 365-0787. Supplied by Commercial Water, contact Tom Beggs, email tom@commercialh2o.com

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractor shall install, the package of equipment with all interconnections, where indicated on Life Support drawings according to manufacturer's recommendations, in a neat and orderly manner, to result in a complete, safe, and functional system.

B. Install interconnect to confirm that the pretreatment equipment is available to deliver water to the RO unit.

C. If an Alternate Manufacture is selected by the Contractor, make all necessary modifications for a complete functional system including, modified concrete supports, piping changes, additional valves, modified electrical power supply, and other required changes for a complete installation.

D. Contractor shall ensure electrical equipment is in conformance with a approved testing laboratory listing and bears certification labeling.

E. Install wiring between the RO controller and each softener controller.

F. Technical Start-Up: The Contractor shall make arrangements with the RO supplier for technical start-up by a factory representative and schedule the session with the Owner’s staff. RO supplier shall assume 4 hours of onsite training time with the Owner’s staff.

G. Thoroughly test all operations of installed unit and demonstrate operations to the Owner’s staff.

END OF SECTION

SECTION 170805 - PRESSURE OZONE CONTACTOR

PART 1 - GENERAL

1.1 USAGE

A. For contacting a solution of ozone gas bubbles with water. See “Ozone Schedule” on the Drawings.

1.2 SUMMARY

A. Pressurized fiberglass vessels with ozone resistant liner. The base design is configured for the *Pentair* “Structural Composite” tank product with a special custom diffuser provided by the specified Ozone Equipment Supplier.

B. The tank must be supplied with a special diffuser, as specified below, available from Ozone Equipment Supplier and may not be available from the manufacturer of the vessel.

C. Contractor shall verify the following dimensions against information given on the Drawings:

1. 63-inch diameter by 86-inch height.
2. 8500-gallon capacity.
3. 16-inch diameter top manway.
4. 6-inch dimeter flanged bottom port.
5. Tripod base support.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: The FRP fabricator shall have at least 5-years of experience in the manufacture of similar items with a record of successful installations.

1.4 COORDINATION

A. Internal mixing nozzles are to be provided the ozone equipment supplier specified in Section 170720.

1.5 TESTING

A. The supplier shall perform an in-shop hydrostatic pressure test.

B. The supplier shall log as-tested data for each vessel and deliver copies of the test data to the customer for approval before shipment.

1.6 SUBMITTALS

A. Submit the Complete set of scale shop drawings indicating all dimensions and a complete material take-off.

B. Copies of pressure testing log for each individual vessel.

C. Submit detailing of diffuser attached to top opening.

D. Manufacturer's certified "Final Inspection Report" addressing completion of resin cure, finish workmanship, and other quality control aspects.

E. Warranty (described below) including warranty against failure from ozone solution.

1.7 WARRANTY

A. Supplier shall warranty each vessel to be free from defects in manufacturing, workmanship or materials and agree to repair or replace any fabrication within five years from date of delivery. Five-year warranty against failure of internal liner against attack from no less than 4 mg/liter ozone in water.

PART 2 - PRODUCTS

2.1 Requirements

A. Contactor Vessel:

1. Contactor Design: Vessel shall have appurtenances for downflow of water and release of gas out a top port.
2. Contactor Vessel Materials: Ozone-resistant polymer liner, with helically wound exterior fiberglass strand for resistance to internal pressures.
3. The fabricator shall be responsible for the design of all shell thicknesses, joint details and all other structural detailing. All resins used in construction of the vessel shall be vinyl ester.
4. Design Pressure: The unit shall be designed for no less than 75 PSI positive working stress. Designed for a negative (vacuum pressure) of 5-inches Hg. Design temperature shall be 100 deg. F.

B. Materials:

1. Inner Shell: Polyethylene (PE) seamless one-piece tank liner.
2. Outer Shell: Continuous strands of fiber-glass with vinyl ester resin.
3. Bottom Base: FRP reinforced tripod base.
4. Alloy Backup Flanges: Type 316 stainless steel.

C. Base support may be a "tripod" design or a cylinder with necessary access ports and shall be of non-metallic construction. Base shall maintain a minimum clear dimension between floor slab and face of bottom flange to allow for installation and service of piping beneath the vessel and shown on the project's scale drawings.

D. Top 16-inch Manway: Shall include a customize flange fitting necessary for water entry and air release connections:

1. Shall allow for pipe connection for incoming two-phase solution of water and ozone gas.
2. Shall include a second connection for release of ozone gas.

E. Bottom 6-inch Port: Shall allow for connection of outgoing water piping with size to match piping on the Drawings.

F. Internal Diffuser: Shall be equipped with a specially designed diffuser to promote mixing of the two-phase solution of ozone gas bubbles and incoming water.

G. Custom Parts: The ozone equipment supplier shall provide a customized flange fitting necessary for water entry connection and air release connection. The custom top port shall include a pipe stub for distribution of water below the air release port.

H. Tank Manufacturer:

1. "Composite Pressure Vessels" by *Pentair,* (800) 279-9404 www.pentair.com; Search for "Composite Tanks" at *Pentair* website.
2. *Canature HuaYu Environmental Products Co., Ltd*. Yixing City Wuxi Jiangsu, China +86 (0510) 8789-9558.

I. Diffuser Manufacturer: The special diffuser inlet shall be provided by the Ozone Equipment Supplier specified in Section 170720.

2.2 OZONE GAS RELEASE VALVES

A. Ozone Gas Release Valves: Specially designed saltwater service gas-relief valve constructed of exceptionally corrosion resistant materials. Housing shall be Type 316L SS or better, or ozone-resistant plastic materials. Internal springs and pivots shall be of Hastelloy C or better.

B. Gas Release Valves at Saltwater Locations: Specially designed gas-relief valve constructed of materials resistant to corrosion by saltwater. Housing shall be Type 316L SS or better, or ozone-resistant plastic materials. Internal springs and pivots shall be of Hastelloy C or better.

PART 3 - EXECUTION

3.1 INSTALLATION - CONTRACTOR

A. Contractor shall not release contacting vessels for shipment until manufacturer's certified Final Inspection Report has been submitted and reviewed by the specifying engineer.

B. Provide or coordinate with Structural for provision of structural concrete house-keeping pads as required for leveling.

C. Tank shall be leveled and bearing support surfaces packed with cement grout. Tank shall be anchored to structural concrete, with stainless steel anchor bolts.

D. Connect piping after setting and leveling of the contactor tank.

E. Install gas-release valve and connect piping to off-gas destruct.

END OF SECTION

SECTION 170810 – LARGE FRACTIONATORS

PART 1 - GENERAL

1.1 USAGE

A. The large fractionator vessels are used in 70 deg F ozonized saltwater containing debris and large particles of uneaten food. In addition to protein skimming, the fractionators serve as ozone contactors. Ozone gas is injected in to the fractionator vessels in concentrations as high as 0.30 ppm ozone in water solution and gas bubbles with much higher gas ozone concentration are also injected in to the fractionator vessels.

B. Large Fractionators" shall be per this specification Section. For "Small Fractionators" see specification Section 170811.

1.2 SUMMARY

A. The specified equipment shall be supplied as a package of equipment by a single source supplier.

B. The work includes the furnishing and installation of the fractionation tower, including support braces, bolts, plates, process piping connections, non-potable sprinkler piping, discharge to floor drain, and other work as shown and noted on the drawings and as specified. The General Conditions apply to this Section as fully as if repeated herein.

1.3 QUALITY ASSURANCE

A. The plastic products shall be designed for stresses to which these products will be subjected during fabrication, erection, and continuous operation as shown on the drawings. All HDPE and plastic components shall be backed by a non-prorated three (3) year factory warranty.

B. Testing Laboratory Requirements for Electronic and Electrical Equipment: Acceptable qualified testing laboratories shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) for Labels on Electrical & Mechanical Equipment. Acceptable listing agencies include Canadian Standards Association (CSA), Intertek Testing Services ITS-ETL, and Underwriters Laboratory (UL). Depending on the "Equipment Category" other testing agencies may be qualified by the State of North Carolina; such as NSF International and other approved research laboratories. The manufacturer shall be fully responsible for compliance with this requirement. If field approval is necessary to meet listing requirements, it shall be completed without delay to the project and at no additional cost to the Owner.

1.4 SUBMITTALS

A. Submit fully detailed shop drawings of all units giving sizes; details of fabrication and construction; methods of assembly and bracing; and locations of hardware, anchors, and all accessories. Submit warranty.

B. Submit product information on all appurtenances including pumps, injectors, valves and sprinkler wash-down timers.

C. Submit proof that installed electrical equipment will bear approved testing agency listing mark or classification markings.

1.5 COORDINATION

A. Electrical: Power connection are made at the pump motor contact points and to the timer/controller for the rinse-down cycles. See Electrical documents for motor starter and wiring requirements. Provide 120 VAC power to wash-down timer controller where 120 VAC controllers are provided.

B. Plumbing: Coordinate work with non-potable water supply, sewer discharge (at floor sink).

C. ORP Sensors: Connection of ORP sensor shall be made on piping included with the packaged fractionators where applications for ozone are identified on the drawings.

D. Vents:

1. Standard Air Vent: Units without ozone gas shall include manufactures standard air vent.
2. Additional Vents: Units operated with ozone gas shall be supplied from the factory with an addition top-vent and check valve for letting in outside air for ozone applications. The standard vent shall be connected to off-gas piping.

1.6 WARRANTY

A. The manufacture shall warranty the body of the fractionator to be free of defects in material and workmanship for 3-years after startup in the water treatment system, or 3-years after Owner acceptance of the units from the installing Contractor, whichever is less.

B. The manufacture shall warranty pumps, and all components attached to the body of the fractionator, to be free of defects in material and workmanship for 1-year after startup in the water treatment system, or 1-year after Owner acceptance of the units from the installing Contractor, whichever is less. The manufacture shall replace any components found defective within the 1-year warranty period.

1.7 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010.

PART 2 - PRODUCTS

2.1 BASIC FRACTIONATOR DESIGN & CONSTRUCTION

A. Design: The fractionator shall be designed by the manufacturer for the optimum removal or surfactants by air floatation. The vessels shall be of the capacity and dimensions indicated on the drawings, self-supporting of gravity loads, cylindrical structure, with flat bottom. The body of

the large diameter fractionators shall be made of a molded, single piece, thick-walled HDPE. The body of small diameter fractionators shall be made of clear acrylic.

B. Chemical Resistance: Main body shall be fabricated with material thicknesses and construction to allow for a long service life with ozonized air injected into the main vessel. Note, while the hypothetical concentration of ozone in solution is 300 ppb or less, bubbles containing 2% (20,000 ppm) ozone may impinge surfaces of the vessels.

C. Influent: Equip with inlet nozzle(s) located high on the water chamber for downward water flow counter-current to the flow of air being injected into the fractionator.

D. Effluent: Discharge water from bottom outlet equipped with a vortex plate to prevent drafting in of bubbles.

1. Equip with a vented “Hartford Loop” piping circuit to maintain a constant head pressure at the effluent.
2. Provide a level control valve in the lower portion of the Hartford Loop.

E. Provide base hold down clips.

1. Body Anchor Clips: Where clips are used for securing the body of the fractionator, clips shall be heavy-duty Type 316 SS clips attached to the side wall of the main body for anchorage to the base or anchorage directly to the structural concrete slab.
2. Base Anchor Studs: Base anchorage for fractionators less than 60-inch diameter shall have no less than four (4) anchor points for 1/2” diameter anchor studs. Base anchorage for fractionators 60-inch diameter shall have no less than four (4) anchor points for 5/8” diameter anchor studs.

F. Venturi Injector Circuit:

1. Pump(s): Factory equipped with recirculation pump(s) for operation of venturi injectors. Pumps shall be of materials with proven saltwater resistance and selected or modified to perfectly match requirements of the venturi injectors.
2. Air Inlet: Equip with inlet specifically for air feed. Air inlet shall have gas flow rate rotometer, needle valve for air flow control, and check valve to prevent back-flow of ozone gas when power is out.
3. Ozone Inlet: Provide fitting for induction of ozone gas downstream of the air inlet.
4. Injectors: Equip with Mazzei educator injectors.
5. Pump shall be co-brand label by RK2/MDM“

G. Wash-Down Systems: Provide the following for each fractionator:

1. Freshwater Sprinklers: Provide spray jets oriented to wash down foam from the top collector. Build unit with external non-potable supply piping to spray jets.
2. Chimney Sweep: Provide a spray jet for cleaning of the interior of the chimney with saltwater when the foam control sprinklers are activated.
3. Provide industrial quality timer/controller, with a built-in HMI touch screen, for programming and activation of sprinkler cleaning cycles. Timer/controller shall be 120 VAC powered.
4. Electric actuated ball valve by *ASAHI America* or *Hayward*. Manufactuer shall match other valves on project

H. Top Foam Collector: Shall include a foam collection cylinder, fabricated from clear acrylic plastic, for easy observation of foam production and collection of foam prior to automatic wash-down to the sewer.

I. Top Vents:

1. Standard Vent: Used for connection to off-gas piping and used as a gas outlet.
2. Additional Inlet Vent: Factory equipped with an additional gas inlet vent and *Spears* brand check valve with low cracking pressure. 1" size check valve for 14" diameter fractionators and smaller. 2" size check valve for 16" diameter fractionators and larger. This is to allow outside air into the top of the unit and prevent a vacuum inside the fractionator from air being drawn to the off-gas destruct unit.

J. Pro-Model Features: Delivered units shall be the "Pro-Models" by the specified manufacturer, including the following features:

1. Plumbed with Sch 40 piping instead of Sch 80 thou.
2. Upgraded wash down system.
3. True union PVC ball valves at all locations.
4. Bulkhead fittings for tank water piping connections (instead of rubber grommets).
5. Asahi manufacturer Valves

2.2 MANUFACTURER

A. Model & Manufacturer: Standard RKPE Models, with HMI wash system controller and actuated ball valve, with additional check valve in the venturi air inlet and additional top inlet vent and check valve. *RK2 Systems* San Marcos, CA (760) 746-7400 www.rk2.com; or approved substitute.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate anchoring with job requirements and install in accordance with Contract Drawings and manufacturer's recommendations.

B. Secure to concrete slab or concrete housekeeping pad.

C. After anchoring, align piping and make piping connections.

D. Install ORP sensor, per specification Section 170455, in water-flooded portion of vertical outlet pipe.

E. All connecting piping shall be specially supported so no external forces are applied on the polyethylene tank. Install support at base of outlet to support vertical load of piping while allowing horizontal movement of fractionator PE shell and outlet piping.

F. Complete electrical power wiring to the injector pump and 120 VAC power to the timer/controller.

END OF SECTION

SECTION 170811 - SMALL FRACTIONATORS

PART 1 - GENERAL

1.1 USAGE

A. The fractionator vessels are used in recirculating saltwater fish aquarium reservoir systems.

B. “Small Fractionators” shall be per this specification Section. For “Large Fractionators” see specification Section 170810.

1.2 SUMMARY

A. The work includes the furnishing and installation of the fractionation tower, including support braces, bolts, plates, process piping connections, valves, and other work as shown and noted on the drawings and as specified. The General Conditions apply to this Section as fully as if repeated herein.

1.3 SUBMITTALS

A. Submit detailed information.

B. Submit warranty.

1.4 WARRANTY

A. The manufacture shall warranty all components attached to the body of the fractionator, to be free of defects in material and workmanship for 1-year after startup in the water treatment system, or 1-year after Owner acceptance of the units from the installing Contractor, whichever is less. The manufacture shall replace any components found defective within the 1-year warranty period.

1.5 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170010.

PART 2 - PRODUCTS

2.1 BASIC FRACTIONATOR DESIGN & CONSTRUCTION

A. Design: The fractionator shall be designed by the manufacturer for the optimum removal or surfactants from saltwater by air floatation. Water flow shall be counter-current sending water from the top of the reaction chamber down through rising bubbles. The internal hydraulics shall be designed for maximum foam production with minimal escape of air bubbles to the outlet.

B. Body: The main body shall be made of clear acrylic plastic. The vessels shall be of the capacity and dimensions indicated on the drawings, self-supporting with a flat bottom.

C. Piping: All plumbing shall be high-quality PVC piping with no traces of primer and all PVC piping shall be cleaned of printed markings. All ball valves shall be true-union, PVC.

D. Effluent: Discharge water from bottom outlet with a hydraulic design to minimize any escape of bubbles from going out the effluent.

E. Foam Collection: The design shall include geometry to avoid collapse of foam back into the riser chimney with a foam collection cup. The unit shall be manually cleaned with no requirement for use of tools.

F. Bubble Circuit: The fractionator shall have a *Mazzei* brand injector included to production of air bubbles.

2.2 MANUFACTURER FOR SMALL FRACTIONATORS

A. Model & Manufacturer: XFLO Model, by *RK2 Systems* San Marcos, CA (760) 746-7400 www.rk2.com;

B. Approved substitute.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated on the Drawings and in accordance with manufacturers recommendations.

B. When saltwater is flowing, demonstrate functionality to the Owner’s operational staff.

END OF SECTION

SECTION 170820 - FRP FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. FRP fabrications in this Section are limited to the following:

1. Square Mesh Grating.
2. Miscellaneous FRP Shapes.
3. Access Manways.
4. Vee Notch Launders.

B. The FRP fabrications are used in submerged, wet/dry, chemical spill, and/or highly oxidized locations.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: The FRP fabricator shall have at least five years experience in the manufacture of similar items with a record of successful installations.

B. Structural Requirements: Fabricators design shall comply with these Specifications and all OSHA and local safety codes. Conservative safety factors shall be used in the design of all products. Working stresses shall not exceed the lower value of one-third of the yield strength or one-fifth of the ultimate strength of the material. The fiberglass products shall be designed for stresses to which these products will be subjected during fabrication, erection, and continuous operation as shown on the drawings.

C. Verification of Resin Cure: Where custom fabrications are constructed for ozonized environments (i.e., vinyl ester resin construction), optimum resin cure shall be checked and confirmed for each product by testing surface hardness in accordance with ASTM D 2583 *Standard Test Method for Indentation Hardness for Rigid Plastics by Means of a Barcol Impresser*.

1.3 SUBMITTALS

A. Submit fully detailed shop drawings of all FRP fabrication work, giving sizes; details of fabrication and construction; methods of assembly and bracing; and locations of hardware, anchors, and all accessories. Design calculations prepared by a Registered Civil or Structural Engineer shall be provided for all fabricated products and railings substantiating the design.

B. Contractor shall be responsible for all fabrication and for correct fitting of members shown on shop drawings. No materials shall be fabricated or delivered to the site until the shop drawings have been reviewed and returned. Accomplish all work to fit field conditions as verified by the Contractor; the shop drawings will not be reviewed for exact fit based on design dimensions.

C. Where custom fabrications are constructed for ozonized environments, submit a manufacturer’s certified Final Inspection Report addressing hardness testing and other quality control aspects. Submit information from resin manufacture giving finished Barcol hardness values.

1.4 FIELD MEASUREMENTS AND TEMPLATES

A. Secure all field measurements required for proper installation. Furnish templates for exact location of items to be embedded in concrete and masonry. The intention of the designer is for this work to be field fit as required.

PART 2 - PRODUCTS

2.1 SQUARE MESH GRATING

A. Unless otherwise noted, ¼-inch nominal bar width, 1-1/2 inch bar depth, of square pattern with bars spaced at 1-1/2 inch on center each way.

B. Grating shall be designed to withstand a 165 lb. concentrated load or a 95 psf uniformly distributed load on a 4-foot span with a safety factor of ten and a deflection no greater than 0.5-inch.

C. Molded from either (a) standard, chemical resistant fiberglass, with isophthalic polyester resin (standard green IFR or standard gray FGI by *Fibergrate*); or (b) vinyl ester resin where used in intimate contact with ozone.

D. Unless otherwise noted, top surfaces smooth with no grit or contour profile and free of sharp edges. Seal cut edges or openings with appropriate resin or epoxy.

E. Submit color for approval.

2.2 MISCELLANEOUS STRUCTURAL FRP SHAPES

A. Manufacturer all components and assemblies for high resistance to corrosion from seawater and saltwater spray.

B. Primary structural components of pultruded premium grade resin meeting ASTM E-84 Class 1 Flame Rating and self-extinguishing requirements of ASTM D-635. Resin material shall have a maximum glass content of 50% and utilize a synthetic surfacing veil for maximum chemical and ultraviolet protection.

1. Use vinyl ester resin for "ozone" applications:
2. "Extren 625"
3. "Creative Pultrusions 1625";
4. or approved substitute.

C. Either vinyl ester or polyester ("Extren 525" or "Creative Pultrusions 1525") resins for general purpose applications.

D. FRP fabrications shall conform to NBS Voluntary Product Standard PS15-69.

1. Custom fabrications used in non-public outdoor areas shall use resilient resin, such as AROPOL 7334 isophthalic polyester by Ashland Chemical, where resistance to impact damage is desired.
2. Custom fabrications used indoors and in public areas shall be constructed of Class I flame retardant resins.

3. Custom fabrications used in public and utility areas shall use *Hetron FR 992* vinyl ester resin by Ashland Chemical or approved substitute flame-resistant resins.
4. Fabrications in submerged or wet/dry ozonated environments shall use vinyl ester resins such as *Hetron* 980 by Ashland Chemical or *Durakane* by Dow Chemical. The particular resin product number used shall be the commodity specifically recommended by the resin manufacture for the actual ozone related application.

E. Manufacturers of grates and FRP shapes:

1. *Aickinstrut/TYCO* Seattle, WA www.alliedeg.com;
2. *Bedford Reinforced Plastics* Bedford, PA (814) 623-8125 www.bedfordplastics.com;
3. *Champion Strut,* Spring, TX (281) 655-8900 www.championfiberglass.com;
4. *Creative Pultrusions Inc*. Alum Bank, PA (814) 839-4186 www.creativepultrusions.com;
5. *Fibergrate Corporations* Dallas, TX (800) 527-4043 www.fibergrate.com;
6. *Seasafe* Lafayette, LA www.seasafe.com;
7. *Strongwell* Bristol, VA (703) 669-1181 www.strongwell.com;
8. *StrutTech* Seattle, WA (425) 885-4403 www.struttech.com;
9. *Ultra Fiberglass Systems* Milwaukee, IE (414) 461-5051 www.ultrafiberglass.com.

2.3 ACCESS MANWAYS

A. Access manways may be constructed of PVC per Section 170220 or of FRP.

B. Blind flange plates shall be of acrylic plastic where a clear viewing port is called out on the Drawings. Clear view-ports, or clear manway covers, shall be shall be hard-coated polycarbonate, acrylic, or approved substitute; sized for the pressure requirement by the supplier. Where clear viewing ports are not called out, the plate may be of the same material as the flange. In the case of fiberglass, the plate may be slightly domed to reduce stresses and material thickness.

C. If manways are constructed of FRP, they shall meet the following requirements:

1. Manway fitting shall be manufactured for Class 100 psi pressure, designed for pressure using AWWA C950-88 Section 2.4, of premium grade vinyl ester resin.
2. Interior pipe surface shall have a multi-layer corrosion barrier not less that than a 100 mil thickness in addition to the structural layer.
3. Flanges shall comply with tolerances given in latest version of NBS Voluntary Product Standard PS 15. All flanges shall have a 150 lb. bolt pattern and bolt holes shall straddle the vertical centerline (i.e., "two-holed," level).
4. Face Detailing: Faces of flanges must be flat, and without "O" ring grooves or other undulations, in order to be compatible with installation of the manway cover.
5. Each FRP manway fitting shall have a manufacturer's certified Final Inspection Report submitted before shipment addressing hardness testing and other quality control aspects.

D. Gaskets shall be in accordance with Section 170010.

2.4 VEE-NOTCH LAUNDERS

A. Assemblies will be used to distribute ozonized water. Constructed of fiber reinforced vinyl ester resin materials. Special attention given to optimize performance of the finished resin laminate products including post-fabrication heat curing. General construction of FRP launders, including allowable cosmetic defects, shall be in accordance with ANSI/AWWA F101 Standard for *Contact-Molded, FRP Wash Water Troughs and Launders.*

B. All troughs and launder shapes shall be designed to contain water over the entire span indicated. Torsional and lateral deflections cause by either water movement or buoyant forces shall be less than L/360. Each unit and its required support structure shall be designed for span load, buoyant load, and water impact and resonance conditions.

C. All FRP shapes, panels, and materials used in this application shall be molded or fabricated using high grade vinyl ester resins such as *Hetron* by Ashland Chemical or *Durakane* by Dow Chemical. The particular resin product number used shall be the commodity specifically recommended by the resin manufacture for the chemical environment where the weirs are to be installed. The use resins and plastic laminates over organic (wood) or metallic core materials is not allowed and will be rejected.

D. Seal all FRP edges and provide final product with smooth surfaces free of projecting glass fibers.

E. Verification of Resin Cure: Where products are constructed of fiberglass resin, optimum resin cure shall be checked and confirmed for each unit by testing surface hardness in accordance with ASTM D 2583 *Standard Test Method for Indentation Hardness for Rigid Plastics by Means of a Barcol Impressor*. Test for proper hardness after post-fabrication heat cure. Additionally, surfaces shall be carefully inspected for imperfections or holidays. The testing and inspection for each vessel will be certified by the manufacturer in a Final Inspection Report.

F. Water Seal: The water seal at each side, and the bottom, need not be “drip-tight” however, the installed seal must limit leaking water to less than 0.5 gpm per linear foot of joint. Manufacture selected solutions include sufficiently flat sealing surfaces, or EPDM rubber gaskets, or application of Dow 795 silicone sealant.

G. Manufacturers:

1. *Augusta Fiberglass* Blackville, SC (803) 284-2246;
2. *Custom Structures (CSC), LLC* Fischer, TX (830) 660-0484 email: jon@cscusa.biz;
3. *Fiberglass Fabricators, Inc*. Smithfield, RI (401) 231-3552;
4. *F R P Composites Inc.* Wisconsin Rapids, WI (715) 421-3770 www.frpcomposites.com/;
5. *Free Flow, Inc*. Omaha, NE (402) 397-8487;
6. *Gemini Fiberglass, Inc*. Colorado Springs, CO (858) 602-9465 or (719) 896 4782 or (858) 602-9465 www.geminifiberglass.com;
7. *Micro-Fab, Inc*. Thedore, AL (800) 221-1397 www.micro-fab.com;
8. *Plasti-Fab, Inc*. Tualatin, OR (503) 692-5460;
9. *Warminster Fiberglass Co*. Southampton, PA (215) 953-1260;
10. *Weirco, Inc*. Ambler, PA (800) 959-0285;
11. *World of Plastics* Fort Pierce, FL (561) 465-1222 or (800) 432-6143;
12. Or approved substitute.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set FRP work accurately at the established lines and levels. Install in strict accordance with approved drawings and actual conditions, true to horizontal or plumb as the case may be, level and square with angles and edges parallel with related lines of the building.

B. Properly locate and build anchor bolts into connecting work. Preset bolts and anchors by the use of templates or such other methods as may be required to locate the anchors and anchor bolts accurately.

C. Set fiberglass grates with sharp edged side down or away from occupied area.

D. When installing Vee-Notch Launders: Installed with sufficiently flat and smooth surfaces to avoid excessive leaking, or install with EPDM gaskets if required to keep leakage less than 0.5 gpm per foot of joints, or install with Dow 795 silicone sealant on joint surfaces. Where installing with Dow 795 silicone sealant, use “Primer P” on concrete surfaces.

E. After assembly, align and accurately adjust various members forming parts of a completed frame before fastening.

END OF SECTION

SECTION 170821 - RAISED SAND TANK FLOORS

PART 1 - GENERAL (See Section 170010)

1.1 GENERAL

A. Used in the bottom of exhibit tanks where sub-floor water distribution is required at sand bottom areas where shown on the Exhibit Drawings. Fiberglass grate, supports and plastic screens to be provided with the Life Support System installation. Sand media to be provided per the Exhibit Design requirements.

1.2 SUBMITTALS

A. Submit information of all materials for review.

1.3 COORDINATION

A. Coordinate extent of grating with the Exhibit Design requirements. Installation of FRP grate for removability, per Detail 7 and 8 / LS8.02 requires coordination with the installation of the exhibit rockwork.

PART 2 - PRODUCTS

2.1 RAISED EXHIBIT SUB-FLOOR DESIGN

A. Sub-Floor Structure: Provide FRP grate media support structure to allow minimum six inch space underneath (or as otherwise shown on the drawings) obstructed only by support stanchions and capable of supporting uniform sand loading of 110 psf per foot of sand depth. Structure shall be molded square mesh fiberglass grate per specification Section 170820.

B. Grate Supports: Length adjustable deck support pedestals, constructed of non-metallic composite material, capacity not less than 1,000 lbs. per pedestal for maximum 36-inch length, with base levelers for up to 0.5 inch per foot floor slope. Provided with bracing system where lateral loads in involved. “Versadjust Adjustable Deck Support” by *Bison Innovative Products*, Co (800) 333-4234; or approved substitute.

C. Mesh: A multi-layer system of square net polypropylene screen shall be placed over support grate structure before placement of sand. The screens selection shall be as given in the following table:

Layer	Product	Hole Size	Thick. & % open	#/1000 sq. ft.
Top Layers (select flyscreen or Internet)	Fiberglass flyscreen or XN-6070 (two layers)	Approximate 0.025" x 0.030"	Approximate 0.014" 35%	Minimum 20.5 lb.
Middle Layer (Optional)	XN-3019	0.030" x 0.037"	0.036" 20%	86 lb.

Bottom Layer	XN-5010/8	0.285" +/- 0.015"	0.110" 45% to 50%	170 lb. to .

D. Bottom Layer: A complete base covering of heavyweight polypropylene mesh netting shall be secured on top of the support grating with nylon cable ties.

E. Middle Layer (Optional): A complete layer of mesh screen secured as necessary with Dow 795 silicone sealant. Place so laps do not match bottom layer laps of the heavyweight screen.

F. Top Layers: Two complete top layers of a fine mesh screen secured as necessary with Dow 795 silicone sealant to prevent any intrusion of sand. Place so laps do not match lapping of previous screens. Contractor may select at his option the Internet XN-6065 product or fiberglass window screen commonly available from the local hardware store.

G. Manufacturer: *Industrial Netting* Minneapolis, MN (763) 971-0871 or (800) 328-8456, www.industrialnetting.com; or *Ultra Fiberglass Systems* Milwaukee, WI (414) 461-5051 www.ultrafiberglass.com, or approved substitute; for top “Flyscreen” layers provide standard fiberglass flyscreen window screen product.

PART 3 - EXECUTION

3.1 INSTALLATION

A. FRP Grate: Fiberglass grating shall be field trimmed and epoxy sealed at edges to prevent wicking. Match walls with a tolerance of 0.5 inch or less.

B. Screens: Prior to placement of the fine mesh screen, the heavy duty mesh screen shall be secured to the fiberglass grate with plastic cable ties. Each layer of fiberglass finer mesh screen shall be secured all around the perimeter of the sand bed with copious quantities of silicone sealant. Within the sand bed, overlap the fine mesh screen to prevent seepage of sand. Arrange overlaps of second layer of fine mesh screen to avoid overlapping in the same places as the first layer.

C. Sand: Provide and install sand beds per Exhibit Design requirements. Special care shall be taken in transporting and placing the sand media to avoid the possibility of contamination and to prevent the media from becoming dirty. Any media which may have become dirty, either before or after it has been placed in the pool, shall either be washed, or removed and replaced by clean media. All media contaminated by organic matter will be rejected.

END OF SECTION

SECTION 170822 - FIBERGLASS DEAERATION TOWERS AND STORAGE TANKS

PART 1 - GENERAL

1.1 USAGE

A. The FRP tanks are used processing filtered water and dissolved gas control and storing freshwater and saltwater.

1.2 SUMMARY

A. Work includes furnishing and installing fiberglass reinforced plastic (indicated as FRP) tank including all appurtenances indicated on the drawings and/or specified herein. The General Conditions apply to this Section as fully as if repeated herein.

B. Design & Fabrication: The manufacture shall be responsible for both design and fabrication of the product to match the geometry and detailing indicated on the Drawings. The manufacture shall be responsible for determining proper material dimensions given information on the Drawings, actual material properties, and requirements of this specification.

C. Reference Drawings: General detailing for construction of the tanks are shown on LS Drawings.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: The tank fabricator shall have at least 5-years experience in the manufacture of similar items with a record of successful installations.

B. Design Requirements: Design shall comply with these Specifications and all OSHA and local safety codes. Use conservative safety factors in the design of all products. Working stresses shall not exceed the lower value of one-third of the yield strength or one-fifth of the ultimate strength of the material. Design products for continuous use and stresses to which these products will be subjected during fabrication, erection (i.e., large-diameter thin-walled tanks may require stiffening ribs).

C. Material Thicknesses: All and/or any material thicknesses given on the Drawings shall be taken as a minimum thickness requirement and shall be verified by the manufacturer for low stress in the material being supplied.

D. Reference Standards:

1. Helically wound vessels shall be constructed in accordance with ASTM D 3299 Standard Specification for Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Chemical-Resistant Tanks.
2. Hand laid-up vessels shall be constructed in accordance with ASTM 4097 Standard Specification for Contact-Molded Glass Fiber Reinforced Thermoset Resin Corrosion Resistant Tanks.
3. Where applicable products shall be in accordance with NBS *Voluntary Product Standard PS 15 – 69* for flange and other miscellaneous FRP construction. Unless noted otherwise, flange thickness shall be per NBS Table 5 for 150 psi design pressure.

1.4 COORDINATION

A. Refer to project drawings for burial depth and external loads.

1.5 SUBMITTAL

A. Submit fully detailed shop drawings of all fabrication work, giving sizes; details of fabrication and construction; methods of assembly; and locations of hardware, anchors, and all accessories.

B. Submit detailed design calculations on the vessels, certified by a Professional Engineer registered in the State of North Carolina.

C. Submit manufacturer's information on major materials or list product references on shop drawings. Submit information from resin manufacture giving finished Barcol hardness values.

D. Submit copy of binding warrantee.

E. After fabrication of vessels, but before shipment, submit a manufacturer's certified Final Inspection Report addressing hardness testing, finish workmanship, and other quality control aspects.

F. Submit provision of marine canvas covering of clear acrylic ports for outdoor installations.

1.6 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the project bound Operations & Maintenance Data Manual per requirements in Section 170100.

1.7 WARRANTY

A. Manufacturer shall warranty each product to be free from defects in manufacturing, workmanship or materials, and shall repair or replace any fabrication within five years from date of delivery.

PART 2 - PRODUCTS

2.1 FIBERGLASS DEAERATION TOWER

A. General: The tank shall be of the capacity and dimensions shown on the drawings. The tank shall be a vertical, self-standing, cylindrical structure of seamless construction, with flat bottom.

B. Wall Thickness:

1. Shall be designed for pressure rating with a factor of safety of 10:1 or greater on the ultimate strength of the material.
2. Tank walls shall be constructed for installation with fixed piping connections (i.e., flexible pipe couplings shall not be required to prevent damage to tank from thermal growth or fill/drain induced wall movements).

C. Deaeration Tower/Tanks shall be fabricated throughout with a premium grade, corrosion resistant vinyl ester resin such as *Hetron* by Ashland Chemical or *Derakane* by Dow Chemical.

D. The interior tank surface shall have a primary corrosion barrier consisting of a 100 mil, resin-rich vinyl ester resin layer reinforced with two-ply, ten mil, Type "C" glass surfacing veil. Underlying the surfacing veil, two layers of glass mat with 70 percent resin content.

E. Composite Side-shell Insulation: Include 2-inch layer of rigid polyurethane insulation bonded to the tank shell and cover. Finish the insulation with a 0.125-inch protective outer fiberglass layer with a pigmented resin coating. Refer to fab sheets and equipment schedule for which required towers and tanks.

F. Top: Openings at the top shall be equipped with durable insect-resistant screens.

G. Pipe Nozzles: Contact Molded or "Built-Up" type flanges per NBS Voluntary Product Standard PS 15 with thicknesses shall not be less than those listed for a design pressure of 150 psi. Filament Wound, "Slip-On," or Compression Molded type flanges shall comply with the tolerances of ASTM D 4024 for 150 psi service. Pipe end flanges shall have a 150 lb. bolt pattern and bolt holes shall straddle the vertical centerline (i.e., "two-holed," level). The fabricator shall take into account stresses typically imposed by piping attached to the flanges and provide robust gussets and/or overlay reinforcement. Flange thickness shall have 50 psi minimum rating, and bolt patten with thickness in accordance with NBS PS15-69, and wall projection to flange face length per the following table:

Pipe Nozzle Diameter per Drawings	FRP Flange Thickness	Projection	Comment
2”	11/16”		Gussets Required
3”	13/16”		Gussets Required
4”	15/16”	6”	Gussets Required
6”	1-1/16”	8”	
8”	1-1/4”	8”	
10”	1-7/16”	10”	
12”	1-3/4”	10”	
14”	1-7/8”	12”	
16”	1-15/16”	12”	
18”	2”	12””	

H. Anchor Flanges: Hold-down anchors shall be designed to transfer forces to the vertical cylinder of the vessel.

I. The tank shall be post-cured prior to shipment.

J. All FRP attachments to the tank shall be made of the same resin as that used to fabricate the tank. All appurtenances shall be as indicated on the drawings and specified herein. All appurtenances shall be subject to shop drawing review.

K. Whether indicated on the drawings or not, the deaeration tower/tanks shall have the following:

1. Minimum of three FRP lifting lugs attached to tank shell (one low on side).
2. Side-mounted flanged manway with sturdy clear acrylic cover.
3. Gaskets shall be EPDM rubber or equal where required.
4. All hardware, bolts, nuts and washers shall be 300 Series stainless steel.
5. Mount tabs for sight gauge or stilling well.
6. Minimum of four FRP tie-down lugs.

L. Top Cover: As shown on drawings.

M. Manway/Viewport: Side mounted, flanged manway/view-port with full face 3/16" gasket(s) and 316 series stainless steel bolts, nuts, and washers. Provide full face 12 ga 300 series stainless steel bolting collar with matte finish exterior surface for distribution of fastener loads. The clear cover shall be acrylic by *Reynolds Polymer* or *Nippura Co*. or approved substitute; or hard-coated polycarbonate "HYZOD AR Sheet" by *Sheffield Plastics* (800) 628-5084; or approved substitute. Thickness shall be selected by the manufacturer for less than 2.4 ksi stress at maximum hydraulic pressure, long-life, and resistance to leak development. Provided with a marine canvas cover, with gromets, and fastened with a chinch cord. Flange thickness shall have 50 psi minimum rating, and bolt patten with thickness in accordance with NBS PS15-69, and wall projection to flange face length per the following table:

Manway Diameter per Drawings	FRP Flange Thickness	Projection
16"	1-3/16"	10"
18"	1-1/4"	12"
20"	1-5/16"	12"
24"	1-1/2"	14"
30"	1-7/8"	14"

N. Color: Light grey.

O. Miscellaneous Structural FRP Shapes: Strongwell Extren 625 or Creative Pultrusions 1625 where fire resistance is required, otherwise Strongwell Extren 525 or Creative Pultrusions 1525.

P. Grating used in conjunction of the construction of fiberglass tanks shall be square mesh molded fiberglass. Grates shall be 1/4 inch nominal bar width, 1-1/2 inch bar depth, of square pattern with bars spaced at 1-1/2 inch on center each way. *Grate Manufacturers*: *IKG Borden*; *Chemgrate Corporation*; *Strongwell*; or *Fibergrate Corporation*.

Q. Structured Tower Packing Media:

1. Provide tank with packing media installed. Trim packing to fit closely to the tank radius. Align layers of structure packing perpendicular to each other.
2. Packing shall be tough virgin PVC construction designed for the purpose of scrubbing and air stripping with cross-corrugated plastic sheets for a maximum impingement of flow. Void space in excess of 95%. Specific surface area in excess of 64 ft2/ ft3. Corrugation angle of 30 degrees. Mixing and redistribution points in excess of 2400/ft3. 10 mil sheet thickness. CF 1200 "ACCU-PAC" manufactured by *Brentwood Industries Inc*.

R. Protective Grid: U.V. stabilized black polypropylene 2" x 2" grid, 1.25-thickness, designed for installation on top of structured tower to avoid damage from walking and hydraulic impact. AccuGrid manufactured by *Brentwood Industries Inc*. and available from *L.S. Enterprises*, Gainesville, FL (239) 851-1175 www.biofilters.com.

S. Drift Eliminators: Blade type drift eliminator designed to remove entrained water droplets shall be installed at the top of FRP towers. Fabricated from rigid, corrugated PVC (or CPVC) sheets conforming to ASTM D 1784. Manufactured to be field-cut, for tight fit, without sacrificing structural integrity.

1. Blade spacing of 0.86-inch (20 mm) with material gauge of 13 mil (0.33mm) thickness for up to 4-ft span or 20 mil (0.51mm) heavy duty thickness for up to 6-span.
2. Models CFUltra or CF80Max by *Brentwood Industries Inc*. www.brentwoodindustries.com ; available from *L.S. Enterprises* Gainesville, FL (352) 379-5626 www.biofilters.com; or approved substitute.

T. Tank Manufacturers:

1. *Custom Structures (CSC), LLC* Fischer, TX (830) 660-0484 email: jon@cscusa.biz;
2. *Hydro Composites,* Stockdale, TX (830) 996-0020 www.hydrocomposites.com;
3. *DT Fiberglass, Inc*. Sacramento, CA (916) 383-9012 www.dtfiberglass.com;
4. *FRP Systems, Ltd.,* Thunder Bay, ON (807) 345-2171 or (807) 345-2171 www.frpsystems.com;
5. *Gemini Fiberglass, Inc*. Colorado Springs, CO (858) 602-9465 www.geminifiberglass.com;
6. *Johnson Custom Fiberglass* Ocala, FL (352) 245-8888 www.jcfiberglass.com;
7. Approved Substitute.

2.2 MISCELLANEOUS STRUCTURAL FRP SHAPES

A. All components and assemblies shall be manufactured for high resistance to corrosion for the intended use. Extren by Strongwell, Creative Pultrusions or approved substitute.

2.3 GRATING

A. Grating used in conjunction of the construction of fiberglass tanks shall be square mesh molded fiberglass. Grates shall be 1/4 inch nominal bar width, 2-inch or 1-1/2 inch bar depth, of square pattern with bars spaced at 2-inch or 1-1/2 inch on center each way.

B. Manufacturers: *IKG Borden* Clark, NJ (201) 815-9500; *Chemgrate Corporation* Woodinville, WA; *Fibergrate Corporation* Dallas, TX.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide concrete house-keeping pads for all flat-bottomed fiberglass tanks; install true and level and square and anchor tank to foundation. Set tanks at established locations to align with piping and other equipment on site.

B. Tanks shall be aligned and adjusted accurately before tightening piping connections.

END OF SECTION

SECTION 170845 - RECTANGULAR FIBERGLASS TANKS

PART 1 - GENERAL

1.1 USAGE

A. See FRP Tank Schedule on the Drawings. Tanks are used with aquarium saltwater.

1.2 GENERAL

A. The work includes the furnishing and installation of custom fabricated glass fiber reinforced resin tanks.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: The tank fabricator shall have at least five years of experience in the manufacture of similar items with a record of successful installations.

B. Design Requirements: Use conservative safety factors in the design of all products. Working stresses shall not exceed the lower value of one-third of the yield strength or one-fifth of the ultimate strength of the material.

C. Shop Testing: Fabricator shall perform a hydraulic test of each tank in shop prior to shipment. Deflections in finished products shall not exceed L/360. The fabricator shall perform modifications by addition of extra materials as required to limit deflection prior to shipment.

D. Material Thicknesses: All and/or any material thicknesses given on the Drawings shall be taken as a minimum thickness requirement and shall be verified by the manufacturer for low stress in the material being supplied.

E. Reference Standard: Tanks shall be constructed using fabrication methods, materials, design and workmanship in accordance with ASTM D 3299 *Standard Specification for Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Chemica-Resistant Tanks*.

1.4 SUBMITTALS

A. Submit fully detailed shop drawings of all fabrication work, giving sizes; details of fabrication and construction; methods of assembly; and locations of hardware, anchors, and all accessories.

B. Submit manufacturer’s information on major materials or list product references on shop drawings. Submit information from resin manufacture giving finished Barcol hardness values.

C. Submit copy of binding warranty.

D. After fabrication of vessels, but before shipment, submit a manufacturer’s certified Final Inspection Report addressing hardness testing, finish workmanship, shop testing and recording of deflections, and other quality control aspects.

1.5 COORDINATION

A. Coordinate finish of FRP tank, and field drilling of holes in tanks, with location pipe penetrations required in FRP tanks.

1.6 WARRANTY

A. The manufacture shall warranty the FRP tank to be free of defects in material and workmanship for 2-years after startup in the water treatment system, or 2-years after Owner acceptance of the units from the installing Contractor, whichever is less.

PART 2 - PRODUCTS

2.1 FRP RECTANGULAR TANKS

A. General: Used for storage and processing of saltwater. The tanks shall be of the capacity and dimensions shown on the drawings. The tanks shall be self-standing, rectangular structures of seamless construction, with flat bottom, vertically plumb side walls with intermediate wall stiffeners, and a top flange stiffener. The tank wall shall be solid, suitable for drilling and installation of tank adapters, and not of a hollow or composite construction other than composite construction of wall stiffeners.

B. Resin: The tank shall be fabricated throughout with a premium grade corrosion-resistant polyester resin resistant to impact damage, minimum Tensil Elongation of 3.7% per ASTM D 638, minimum Heat Distortion Temperature of 200°F, such as AROPOL 7334 resilient isophthalic polyester by *Ashland Chemical, Dow Chemical* or approved substitute with a superior vinyl ester resin.

C. Corrosion Barrier: Interior tank surface and all surfaces of fiberglass material inside tank shall have a primary corrosion barrier consisting of a 100 mil, resin-rich layer on the side exposed to the hypochlorite. Resins for sodium hypochlorite environments shall be cured using dimethylaniline (DMA), benzylperoxide (BPO), or other recommended curing systems.

1. Two plies of Type "C" glass veil, to a thickness of approximately 20 mils, consisting of 5% glass and 95% resin.
2. Two layers of chopped strand glass mat, to a thickness of 80 mils, with 70 percent resin content.

D. Thixotropes: Linings shall contain no thixotrope, for either primary or secondary laminates or reinforcements. Thixotropes shall not be used in top-coats which will be exposed to the environment. Secondary lay-ups, such as joints and flanges, shall be well cured and contain the minimum amount of thixotrope possible.

E. Wall Thickness: The fabricator of the tanks shall be responsible for determination of tank wall thicknesses. Tank walls shall be designed with working stresses not exceeding one-third of the yield strength of one-fifth of the ultimate strength of the material with the tank filled to the top rim with water. The lower value for yield or ultimate strength shall govern. The tank wall thickness shall limit deformations to less than L/360 or shall otherwise have stiffeners provided integral with the wall construction for limitation of deformations.

F. Tank Wall Stiffeners: Built with tank wall stiffeners integral with the tank wall construction, as required, to limit deformation to less L/360. Stiffeners may be solid FRP, or Balsa wood filled, or stiff EPS foam filled. Fabricator must align any stiffeners not to interfere with piping nozzles.

G. Flanges: Contact Molded or "Built-Up" type flanges per NBS Voluntary Product Standard PS 15 with thicknesses shall not be less than those listed for a design pressure of 150 psi. Filament Wound, "Slip-On," or Compression Molded type flanges shall comply with the tolerances of ASTM D 4024 for 150 psi service. Flanges shall have a 150 lb. bolt pattern and bolt holes shall straddle the vertical centerline (i.e., "two-holed," level). The fabricator shall take into account stresses typically imposed by piping attached to the flanges and provide robust gussets and/or overlay reinforcement.

H. Attachments: All FRP attachments to the tank shall be made of the same resin as that used to fabricate the tank. All appurtenances shall be as shown on the drawings and subject to shop drawing review.

I. Provide threaded drain port with PVC plug fitting.

J. Exterior Finish: A resin-rich layer shall be applied over the final structural layer of reinforcement. A pigmented, ultraviolet resistant, gloss resin shall be applied to the exterior of all portions of the vessel. The minimum acceptable level of workmanship and finish shall conform to the requirements of ASTM C 582 "Specification for Contact-Molded RPT Laminates for Corrosion Resistant Equipment."

K. Exterior Color: Light grey.

L. Curing: The tanks shall be post-cured prior to shipment at a minimum of 180 deg F for a minimum of two-hours.

M. Resin Cure Check: Prior to shipment, test surfaces for hardness in accordance with ASTM 2583 *Standard for Rigid Plastics by Means of Barcol Hardness Impressor.* All resin inside the tanks shall exceed 90% of the resin manufacturers published Barcol hardness.

N. Any metal parts (flange bolts for sectional tanks) shall be of Type 316 stainless steel.

O. Manufacturers:

1. *Augusta Fiberglass,* Blackville, SC (803) 284-2246;
2. *Custom Structures (CSC), LLC* Fischer, TX (830) 660-0484 email: jon@cscusa.biz;
3. *Hydro Composites,* Stockdale, TX (830) 996-0020 www.hydrocomposites.com;
4. *Johnson Custom Fiberglass,* Ocala, FL (352) 245-8888 www.jcfiberglass.com;
5. *Industrial Plastics* Lakeland, FL (863) 646-8551 bburhans@ips-frp.com;
6. *Micro-Fab, Inc*. Theodore, AL (800) 221-1397 www.micro-fab.com;
7. *R&B Aquatics Distribution, Inc.* TX (800) 259-9812 www.rbaquatic.com
8. *Waterdog Products*, El Cajon, CA www.waterdogproducts.com (619) 441-9688;
9. or approved substitute.

2.2 MISCELLANEOUS STRUCTURAL FRP SHAPES

A. All components and assemblies shall be manufactured for high resistance to corrosion for the intended use.

2.3 GRATING

A. Grating used in conjunction of the construction of fiberglass tanks shall be square mesh molded fiberglass. Grates shall be 1/4 inch nominal bar width, 1-1/2 inch bar depth, of square pattern with bars spaced at 1-1/2 inch on center each way.

B. Manufacturers: *IKG Borden* Clark, NJ (201) 815-9500; *Chemgrate Corporation,* Woodinville, WA; *Fibergrate Corporation*, Dallas, TX.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide concrete housekeeping pads for all flat-bottomed fiberglass tanks; install true and level and square. Set tanks at established locations to align with piping and other equipment on site.

B. Tanks shall be aligned and adjusted accurately before tightening piping connections.

C. Secure tanks to concrete pad/slab using Type 316 SS anchor bolts.

END OF SECTION

SECTION 170846 - SINGLE WALL MIXING TANK

PART 1 - GENERAL

1.1 SUMMARY

A. The General Conditions shall apply to this Section as fully as if stated herein. The work includes the furnishing and installing of all plastic tanks, and flexible connecting fittings, as indicated on the drawings and as specified.

1.2 EXPERIENCE

A. The plastic tank manufacturer shall have at least five year's experience in the manufacturer of similar items with a record of successful installations.

1.3 SUBMITTALS

A. Submit fully detailed shop drawings of all plastic tanks giving dimensions; details of composition and construction; methods of installation and bracing; and locations of appurtenances, hardware, anchors, and all accessories.

1.4 MAINTENANCE AND OPERATIONAL DATA

A. Include pertinent information in the product bound Operations & Maintenance Data Manual per requirements in Section 170010.

PART 2 - PRODUCTS

2.1 SINGLE WALL MIXING TANK

A. Material: Mixing tanks (the Base Mixing Tank) shall be specifically design for mixing with molded in gallon and liter markings on the side shall be rotationally-molded from Polyethylene. Color shall be natural (translucent white) with liquid level volume markings.

B. Size, shape and appurtenances shall be as indicated on the drawings. 48 inch diameter by 53-inch tall, 360-gallon capacity, included with hinged lid.

C. Accessories:

1. 12” bottom clearance poly stand.
2. Tank-wall connection fittings (may be field-installed bulkhead fittings).
3. Connecting Fittings*: Fittings external to the tank to allow for expansion and contraction may include flex couplings, “S” shaped flexible wall pipe, or flexible pipe installed for two directions of movement.
4. 2” vent
5. Hinged top cover.

*Where the tank wall radius does not allow for a mechanically fastened bulkhead fitting, the tank shall be manufactured welded gusseted fittings, or have fittings attached by a qualified plastic tank welder.

D. Manufacturer:

1. Open top total drain dish bottom tank by Snyder Industries www.snydernet.com Lincoln, NE (402) 467 5221;
2. *Chemical Containment, Inc*. Lake Wales, FL (800) 346-7867 www.chemicalcontainers.com;
3. or approved substitute.

PART 3 - EXECUTION (See also 170010)

3.1 INSTALLATION

A. Set tanks at established lines and levels.

B. After assembly, the various members forming parts of a completed frame shall be aligned and adjusted accurately before being fastened.

C. Connect piping in side walls of tanks with bulkhead adapters where nozzles are not provided with tank. See Section 170220.

D. All polyethylene (PE) tanks shall be installed with provisions, approved by the tank manufacturer, to allow for expansion and contraction.

END OF SECTION

SECTION 170933 – LSS AUTOMATED CONTROLS

DIVISION 1 - GENERAL CONTRACT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. The General Provisions of the Contract, including General, Supplementary, and Special Conditions, the Owners Policy and General Requirements, apply to work specified in this section. Subcontractor must familiarize himself with the terms of the above documents.

B. All bidders must be control system suppliers and integrators in the business of providing life support control systems for a minimum of five (5) years. Bidders shall also have in-house experience in the operation of life support control systems for large aquariums. This operational experience shall consist of a minimum of (5) years in responsible charge of operating life support system of similar size, type, extent of automated control and complexity. Bidders shall submit an experience summary and resumes documenting installation and operating experience as part of the submittal.

C. All bidders shall have at least one (1) in-house licensed Control System Engineer with a minimum of five (5) years of experience designing life support control systems for large aquariums. Bidders shall submit a list of relevant design experience and evidence of current & valid engineering license registration.

D. All bidders shall be approved by the design engineer as listed herein. All bidders must have direct experience in life support exhibit system control similar to the system as specified.

E. All bidders must have trained and authorized representation for ongoing support and service. Third party service is not acceptable.

F. All bidders must have an in-house staff dedicated to software generation and preparation of sequences of operation for Aquatic Life Support Systems. This staff shall be used for both initial software design and implementation and be available for continued system support and service.

1.2 DEFINITIONS

ACS - Automated Control System
AI - Analog Input
AO - Analog Output
DI - Digital Input
DO - Digital Output
EIA - Electronic Industries Alliance
GUI - Graphical User Interface
HMI - Human Machine Interface
IEC – International Electrotechnical Commission
IEEE - Institute of Electrical and Electronics Engineers, Inc.
LAN - Local Area Network
LSS - Life Support System
OIT - Operator Interface Terminal
ORP - Oxidation Reduction Potential

PAC - Programmable Automation Controller
PLC - Programmable Logic Controller
PWM - Pulse Width Modulation
XML - Extensible Markup Language
W3C - World Wide Web Consortium
UL – Underwriters Laboratories Inc.

1.3 SCOPE OF WORK

A. The life support Automated Control System (ACS) shall be a stand-alone system and shall include but not be limited to the control of the following equipment and their processes:

1. Pumps
2. Electrically actuated valves
3. Flow devices
4. Water temperature control
5. Pressure transducers to monitor water level
6. Pressure transducers to monitor pipe pressure
7. Safety devices
8. Ozone equipment and devices
9. Drum filters
10. Reverse osmosis package

B. Ozone System equipment and devices

1. Analytical devices

C. The work covered under this section of the specifications and drawings include the complete installation and coordination of the life support control system.

D. The hardware and I/O control points list identifies those points that are to be addressed by the operator control workstation computer(s) and incorporated into the life support control system.

E. The Controls Supplier shall furnish a complete monitoring and control system including supplying the necessary hardware as specified and the operating and applications software necessary to perform the control sequences of operation. The software program required will be turned over to the Owner ready for use including all operation parameters, set points, and schedules.

F. The Drawings and Specifications are not intended to show all details. The Contractor shall secure satisfactory information before submitting the proposal and include in the proposal a sum sufficient to cover all items of labor and material required for the complete installation of the devices specified for the system described.

G. The Controls Supplier shall furnish all control elements associated with the control system as indicated on instrument control drawings, except those specified to be furnished by owner or other contractor. Installation of all piping hardware devices will be by the Life Support Mechanical Contractor.

H. The Electrical Contractor shall provide all conduit and wiring. Termination between all control elements and control cabinet(s) will be by the Electrical Contractor.

I. Testing laboratory requirements: All applicable equipment shall be in conformance at least one of the following product testing laboratories listed in Washington State Department Labor & Industries document WAC 296-46B-999: ASC Engineering Service (ASC), Applied Research

Laboratory (ARL), American Industrial Testing Labs, LLC (AIT), American Products Safety Co. (APS), CSA International (CSA), CSA International (CSA), Entela (Entela Mark), FM Approval (FM), Intertek Testing Services NA, Inc. (ETL), LabTest Certification Inc., MET Laboratories, Inc. (MET), NSF International (NSF), Omni-Test Laboratories, QAI Laboratories Ltd., SGS North America Inc., TÜV SÜD America Inc. (TUVAM), TUV Rheinland of North America (TUV), Underwriters Laboratories, (UL), and Wyle Laboratories, Inc. (WL).

J. The Contractor shall verify proposed ACS cabinet locations, install electrical power wiring and low-voltage control wiring, and recommend relocation of proposed ACS cabinets where economically justified by required wiring length.

1.4 COORDINATED WORK

A. The Controls Supplier shall cooperate with contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others work.

B. It will be the duty of the Controls Supplier to work in cooperation with the Owner and with contractors and employees rendering such assistance and so arrange their work such that the entire project will be delivered complete in the best possible condition and in the shortest time.

1.5 INTEROPERABILITY

A. The Controls Supplier's ACS shall be fully compatible with the infrastructure being planned by others for the Aquarium project. The new LSS ACS GUI shall be configured to control and monitor all existing LSS ACS infrastructure, presenting both new and existing LSS in a seemless integrated user interface.

PART 2 - PRODUCTS

2.1 SUPPLIERS

A. All manufacturers listed herein shall meet all of the requirements of this specification.

B. All equipment and software proposed by the Controls Supplier shall be currently in manufacture. No custom products shall be allowed unless required by the specification. The manufacturer for parts, repairs, and software revisions shall support all products.

C. The basis of design for this project is RCK, Controls. San Diego, CA (858) 569-7141 www.rckcontrols.com, or approved equal.

2.2 OPERATING ENVIRONMENT

A. The operator control workstation computer shall operate in an environment of 32-104 degrees F and 10-90% relative humidity.

B. PLCs, PACs and I/O multiplexers shall operate in an environment of 32 to 131 degrees F. All control components shall be installed in enclosures suitable for a saltwater corrosive environment.

2.3 AGENCY APPROVALS

A. All equipment shall be in conformance with all local, state and federal codes, statutes and ordinances where they apply, including UL approvals. All Control Cabinets containing PLCs, PACs, I/O or any other devices shall be UL 508A labeled. The manufacturer of equipment shall be fully responsible for compliance with these requirements.

PART 3 - EXECUTION

3.1 SUBMITTALS

A. Drawings shall be prepared on AutoCAD or ePlan software and provided in both AutoCAD DWG and Adobe PDF formats. In addition to the drawings, the Controls Supplier shall furnish electronic media containing the identical information.

B. Drawings shall include schematics of the system showing all connected points with reference to their associated hardware. Typical will be allowed where appropriate. Drawings shall include control cabinet(s) layout and design.

C. Submittal data shall contain manufacturer's data on all hardware and software products required by the specification. In addition, submittals shall contain sequences of operation, point list, and a complete description of the graphics, reports, alarms and configuration to be furnished with the workstation software. Submittals shall include:

1. I/O points list.
2. Submit a plan of proposed ACS cabinet location and a corresponding list of I/O points for each ACS cabinet.
3. Sequence of operation using descriptive prose.
4. Complete description of graphics, reports, alarms and configuration of the workstation software.
5. Submit six (6) copies of submittal data and shop drawings to the Engineer for review prior to ordering or fabrication of the equipment. The Controls Supplier prior to submitting shall check all documents for accuracy.
6. Prior to system testing, submit complete and verified listing of actual values for all factor and field configurable setpoints, DIP switch settings, etc., along with installed firmware and software revision information for all sensors, transmitters, variable frequency drives, etc. Update the list with any changes that are made during testing and adjustment.
7. The Engineer will make corrections, if required, and return to the Controls Supplier. The Controls Supplier will then resubmit with the corrected or additional data. This procedure shall be repeated until all corrections are made to the satisfaction of the Engineer and the submittals are fully approved.

3.2 ELECTRICAL WORK

A. The Controls Supplier and contractors installing elements defined herein shall refer to the Electrical Division of the specification for electrical standards and methods for installation of this work.

3.3 CONSTRUCTION RECORD DOCUMENTS

A. During the installation phase, all changes to the scope of work must include a written change order inclusive of pricing before work is to proceed. The owner or the owner's representative must sign this change order.

3.4 OPERATING AND MAINTENANCE MANUAL

A. The operation and maintenance manuals shall contain all information necessary for the operation, maintenance, replacement, installation, and parts procurement of the entire control system.

3.5 TESTING

A. Each point in the system shall be tested for both hardware and software functionality. In addition, the system under control will be tested against the appropriate sequence of operation and will include onsite modifications to the operating system as is necessary. Successful completion of the system operational test shall constitute the beginning of the warranty period.

3.6 WARRANTY

A. The Controls Supplier shall warrant the software and process logic for 12 months after system acceptance or beneficial use by the owner. During the warranty period, the Controls Supplier shall be responsible for all necessary revisions to the software as required to provide a complete and workable system consistent with the intent of the sequence of operation for the ACS.

B. All system hardware warranties are those provided by the specific hardware manufacturer.

3.7 TRAINING

A. A minimum of 16 hours on site system training will be required. Training shall include system operation, component maintenance and software configuration. ACS provider shall agree to recording on video by Owner at time of instruction.

PART 4 - CONTROL SYSTEM

4.1 GENERAL

A. The LSS ACS shall encompass the controls and operator interfaces described herein to perform direct control of the specified equipment. In addition to the specified hardware, software and field devices, the Controls Supplier shall furnish all labor to engineer, program and provide installation of the automated control and monitoring system.

4.2 PRODUCTS

A. The LSS ACS shall consist of a Operator Control Station Computer connected with one or more distributed PLCs/PACs located within control cabinet(s) communicating with intelligent I/O and

all input and output devices necessary to accomplish complete automatic monitoring and control of the LSS processes

B. The distributed PLCs/PACs shall be the primary controlling devices for LSS operations.

4.3 OPERATOR CONTROL WORKSTATION COMPUTER DESCRIPTION

A. The Operator Control Station computer shall be an Intel® Core™ i7 class processor based computer with performance equal or better than:

1. Intel® Core™ i7 Processor or better
2. 27" Monitor, 1920 x 1080 screen resolution
3. 32 GB RAM
4. 1 TB, solid state disk drive
5. Gigabit Ethernet
6. The Operator Control Station Computer operating system shall be Microsoft Windows 11 Professional or most recent applicable software.

4.4 PROGRAMMABLE AUTOMATION CONTROLLER (PAC) DESCRIPTION

A. The PAC shall be a microprocessor based embedded controller whose kernel, OS and applications reside on solid state media and provide the following minimum software, electrical and physical characteristics:

Software

OS:	Windows 10 Embedded or comparable most recent applicable operating system.
Applications:	RCK Embedded ACS Software Suite or comparable: Alarm Controller, Datalog Controller Event Log Controller, Event Manager, PID Controller, Pump Controller, Scripting Controller, Valve Controller
Drivers:	BACnet, Ethernet/IP™, Mistic, Modbus (TCP, RTU & ASCII), SMTP, TAP, WCTP, Mistic, Modbus, Optomux, SMTP, WCTP

Hardware

Basis of Design	Phoenix Contact BL2 BPC 7000 RCK 03
CPU:	1.8 GHz Intel® ATOM ™ D525
Mounting Type:	DIN rail
Ethernet:	2 controllers: 10/100/1000 Mbps
USB 2.0:	Four ports

Serial:	4 Serial channels: RS-232/422/485 levels
Memory:	8 GB DDR2 SODIMM
Operating Temperature	-20°C to +50°C

4.5 PROGRAMMABLE LOGIC CONTROLLER (PLC) DESCRIPTION

A. PROGRAMMING

1. The programming software package must be IEC 61131-3 compliant supporting Sequential Function Chart (SFC), Instruction List (IL), Structured Text (ST), Ladder Diagram (LD) and Function Block Diagram (FBD) programming languages.

B. COMMUNICATION PORTS

1. Ethernet: 2 x 10/100 Mbps with RJ-45 connector supporting one or more of the following protocols
    a. EtherNet/IP™
    b. Modbus/TCP
    c. BACnet/IP
2. Serial: EIA/RS-485 supporting one or more of the following protocols
    a. Modbus RTU
    b. Modbus ASCII
    c. BACnet/MSTP
    d. CANOpen™

4.6 ENVIRONMENTAL

A. Minimum Operating Temperature Range: 32 - 131 °F

4.7 NETWORKS AND OPERATOR COMMUNICATIONS

A. General - the communications architecture shall support two (2) physical media links types and shall be firewalled or totally physically isolated from any other network.

B. An IEEE 802.3 “Ethernet” LAN designed to support intercommunications between the host Operator Control Workstation(s), PLC(s), PAC(s) and Internet based web services. Operator Control Workstation(s), PLC(s) and PAC(s) must therefore be furnished with network interfaces supporting Ethernet connections to the LAN. The LAN must feature a connection to the public Internet. Internet service and access to such shall be the responsibility of the owner.

C. An EIA-485 (formerly RS-485) communications fieldbus supporting binary data exchange in a multipoint network consisting of dedicated I/O hardware for the operation of the LSS. The EIA-485 bus must support a minimum data rate of 9600 baud over a maximum length of 4000 feet and 32 nodes. Extended lengths and/or extra nodes will require a network repeater or separate EIA-485 bus. The PLC/PAC must be furnished with EIA-485 serial port(s) to communicate on the dedicated I/O bus.

4.8 NETWORK AND FIELDBUS COMMUNICATION PROTOCOLS

A. General - implemented protocols shall be published, non-proprietary industry standards. Acceptable protocols include:

1. OPC-UA
2. Modbus (ASCII, RTU and/or TCP)
3. EtherNet/IP™
4. CANOpen™
5. BACnet (MSTP and/or IP)
6. Mistic
7. HTTP
8. SMTP
9. WCTP

PART 5 - INSTALLATION

5.1 CONTRACTOR RESPONSIBILITIES

A. The mechanical and electrical installation of the LSS ACS shall be performed by others. However, all installation shall be coordinated with the Controls Supplier by way of conference calls as needed and all direction and changes shall be recorded in written documentation. The Controls Supplier shall certify all work as proper and complete and shall reflect actual installation on the project record documentation as specified. Under no circumstances shall the design, scheduling, coordination, programming, training, and warranty requirements for the project be delegated to a subcontractor.

5.2 CLEANUP

A. At the completion of the work, all equipment pertinent to this contract shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this contract.

5.3 IDENTIFICATION

A. Identify all control wires with labeling tape or sleeves using words, letters, or numbers that can be exactly cross-referenced with as-built drawings.

5.4 INSTALLATION PRACTICES

A. Install all conduits and enclosures in accordance with specifications of Division 26.

B. Conduit, in non-finished areas where possible, will be concealed in ceiling cavity spaces, plenums, furred spaces, and wall construction. Exposed conduit will run parallel to or at right angles to the building structure.

C. Where sensor wires leave the conduit system, they are to be protected by a watertight non-metallic cord grip connector.

D. All control wiring running down exposed walls to controls or control panels shall run in conduit in accordance with Division 26.

E. All control wiring in concrete walls or floors shall run in conduit in accordance with Division 26

5.5 POWER WIRING REQUIREMENTS

A. All equipment power wiring shall be the responsibility of the Electrical Division Contractor.

B. The power shall be obtained from dedicated circuits on the nearest available 120V panel and clearly labeled. Power for any control equipment that is controlling equipment that operates under emergency power shall be obtained from emergency power panels.

C. All power wiring for the control equipment shall be done with a dedicated earth ground by means of wire media only, originating at the power service source earth ground. This applies to all controllers along with workstations.

D. Power required for motorized valve actuators, and field devices shall be sourced from ACS cabinet. Controls provider shall design cabinets to accommodate powering of all devices shown on drawings calling to be powered from ACS

5.6 CONTROL WIRE & CABLE REQUIREMENTS

A. All control wiring materials and labor shall be the responsibility of the controls supplier.

B. Discrete signals shall use stranded copper wire, type THHN/THWN, single conductor, insulated to 600 V, minimum No. 14 AWG, sized and color coded as required by applicable NEC standards and codes.

C. Analog signals shall use 20 AWG twisted, shielded pair cabling with stranded tinned copper shield drain wire, Belden 8762 or equivalent.

D. Communication fieldbus data signals for EIA/RS-485 serial networks shall use twisted, shielded two pair cabling with stranded tinned copper shield drain wire. Cable shall have a characteristic impedance between 50 to 120 Ohms and the capacitance between conductors must be less than 30 pF/ft (10 – 15 pF/ft is ideal), Belden 9842 or equivalent.

E. Surge protection (Phoenix Contact DATA-PLUGTRAB or equivalent) shall be utilized on all communication cables.

F. Communication cabling for IEEE 802.3 Ethernet networks shall use CAT5E or equivalent cable with RJ-45 connectors for transmission paths under 100 m (328 ft) in length. For distances greater than 100 m and shorter than 2 km multi-mode fiber optic cable shall be used.

G. Surge protection (Phoenix Contact DATATRAB or equivalent) shall be utilized on all copper Ethernet communication cables.

H. The LSS Controls Supplier may recommend relocation of proposed ACS cabinets where economically justified by required wiring length.

5.7 WIRING INSTALLATION PRACTICES

A. Install all conduits and enclosures in accordance with specification Division 26.

B. Conduit, in non-finished areas where possible, will be concealed in ceiling cavity spaces, plenums, furred spaces, and wall construction. Exposed conduit will run parallel to or at right angles to the building structure.

C. Where sensor wires leave the conduit system, they are to be protected by a watertight non-metallic cord grip connector.

D. All control wiring running down exposed walls to controls or control panels shall run in conduit in accordance with Division 26.

E. All control wiring in concrete walls or floors shall run in conduit in accordance with Division 26.

PART 6 - FIELD DEVICES

6.1 DESCRIPTION

A. Included field devices are all analytical components, sensors, transmitters, transducers, and switches necessary for the operation of the control system, except those specified to be furnished by owner or other contractor.

B. All flow and ORP instrumentation monitors shall be fed 24 VDC power from the same ACS control cabinet the associated signal is wired to. 120 VAC power for instrumentation monitors is not allowed.

C. All electrically actuated motorized valves shall be fed 120 VAC power sourced from ACS control cabinet the associated signal is wired to. Power supply to ACS control panels shall be sufficient for powering of all actuated valves, field devices, and other items shown on LS drawings to be powered by ACS

D. All field devices shall include the associated wiring, mounting, enclosures, and includes control valves, valve actuators, and conventional controls necessary for a completely functioning system in accordance with the sequence of operation.

6.2 QUALITY ASSURANCE

A. The Controls Supplier shall provide all field devices per the performance requirements set forth in this section. All devices selected by the Controls Supplier must be contained in the Submittal documents and are subject to approval by the Engineer.

B. All sensors and signal conditioning equipment will be of the type which are universally accepted in the industry, can easily be second sourced and are compatible with all of the manufacturer's equipment.

6.3 INPUT DEVICES

A. Input devices for the LSS ACS are specified in their respective sections of Division 17. The LSS control provider shall coordinate with the LSS contractor what field devises will be purchased for installation on project that interface with the LSS ACS

B. The system shall maintain the specified analog end-to-end accuracy throughout the warranty period from sensor to readout.

C. Transducers may be supplied as an integral unit with the field sensor, or mounted separately in a field interface panel. All transducers will be calibrated.

D. Sensors (transducers) will be appropriately packaged for the location.

E. Architectural housing for space mounting

F. NEMA 4X housings and enclosures required throughout project.

G. The sensor/transducer shall be selected to withstand ambient conditions where:

H. Moisture or condensation is a factor

I. Vibration exists from ductwork, equipment, etc.

J. Reasonably expected transient conditions exist for temperatures, pressures, and humidity, outside the normal sensing range

K. Exposure to fresh and salt water is a factor

L. The sensor/transducer will be appropriately selected to most closely match the expected sensing range.

M. System accuracy of sensed conditions shall be as follows:

1. +/- 0.5 F for water temperatures in the 0 to 100 F range
2. +/- 0.25% of Full Span for pressure switches
3. +/- 3% for water flow

N. Dry contacts shall be provided for all discrete signals tied to ACS digital input I/O. The contacts will be wired normally open or normally closed as required.

O. Temperature sensors will be RTD’s with 4-20 mA transmitter. See specification Section 170430.

6.4 ELECTRIC ACTUATORS

A. See specification Section 170140.

PART 7 - FIELD INTERFACE DEVICES

7.1 INPUT/OUTPUT

A. Inputs - shall provide inputs capable of accepting information on any point in the form of a temperature, voltage, digital, contact closure, or pulse counter. All AC inputs shall be optically isolated up to 1500 V, all inputs shall be optically isolated up to 500 V.

B. Analog Inputs - the Analog Input (AI) function shall monitor each analog input, perform A/D conversion, and hold the digital value in a buffer for interrogation. The A/D conversion shall have a minimum resolution of 12 bits. Input ranges shall be within the range of the specified I/O.

C. Analog Outputs - the Analog Output (AO) function shall provide an analog output signal, perform D/A conversion, and hold the digital value in a buffer for interrogation. The D/A conversion shall have a minimum resolution of 12 bits. Output ranges shall be within the range of the specified I/O.

D. Digital Inputs - the Digital Input (DI) function shall accept dry contact closures and voltage level transitions. An LED shall be provided to indicate the state of each digital input.

E. Digital Output - the Digital output (DO) function shall provide contact closure for momentary (Pulse Width Modulation) and maintained operation of field devices. Output pulse width shall be selectable.

F. Modbus Protocols – shall provide inputs and outputs capable of communicating with field devices delivered with Modbus connection ports. The baseline system shall be programmed in CoDeSys and comply with IEC 61131-3 standard.

G. Manual overrides shall be reported to the controller at each update. An LED shall be provided to indicate the state of each digital output.

7.2 POWER SUPPLY

A. Power supplies will operate from 100-240 VAC, 50/60 Hz power, with a tolerance of ± 20%. Line voltage below the operating range of the system shall be considered outages. The power supply shall contain over voltage surge protection and require no additional AC power signal conditioning.

B. 24 VDC control logic power and field instrument power shall be fed from separate power supplies that in turn are fed from separate circuit breakers out of an emergency power backed breaker panel.

1. Primary control logic power in each ACS Control Cabinet shall be battery backed by DIN rail mount 24 VDC UPS system.
2. 24 VDC field instrument power is not required to be fed by a UPS system and shall remain isolated from all ACS control logic power.

C. The ACS package shall include a 120 VAC UPS with capacity to continuously run workstation PC for minimum of 1 hour.

PART 8 - COMPUTER and CONTROL SYSTEM SOFTWARE

8.1 DESCRIPTION

A. This section describes the software capabilities for the entire system, inclusive of process logic as required of the PLC(s)/PAC(s).

8.2 AUTOMATIC RESTART AFTER POWER FAILURE

A. Upon restoration of power, the PLC(s)/PAC(s) shall automatically and without human intervention: update all monitored functions; resume operation based on current, synchronized time and status, and implement special start-up strategies as required.

B. When utility power is restored, ACS shall automatically restart if needed.

8.3 OPERATOR CONTROL WORKSTATION SOFTWARE

A. The Control System application software shall provide a Graphic User Interface (GUI) to the operator. The GUI design will provide an intuitive interface for the operators. Included will be dynamic graphical elements representative of the physical equipment connected to the control system. The dynamic images must change appearance to match the current state of the physical equipment, e.g. piping shall indicate the presence of flow, pumps shall indicate On/Off status.

B. The GUI shall be password protected. Individual users must be assigned passwords and access permissions. Passwords shall consist of alphanumeric characters. Access permissions shall be defined by group level. A minimum of 3 user group levels shall be supported using the standard nomenclature of “Viewer”, “Operator” and “Supervisor”.

C. Viewer – Has permission view screens as prescribed by Supervisors. All control functionality is disabled for users of this level.

D. Operator – Supersedes access permissions defined for Viewers by having access to control functionality. Not permitted to tune PIDs, change set points, modify users, modify custom screens or modify I/O configuration.

E. Supervisor – Has access to all functionality included in the GUI.

F. The GUI shall be a multiple document interface displaying standard utility screens and supporting creation of customized screens. Standard utility functions shall include point control, report generation, datalog, event log, PID tuning, alarms, alarm paging/e-mail, operator log and user/password management. Customized screens shall support embedded graphics and intelligent user controls dynamically linked to I/O points and ACS processes providing a real-time graphical representation of the LSS and its subsystems in a standard P&ID format. The Controls Supplier shall initially create a set of custom screens in number and scope to adequately provide complete control and display of data pertaining to the LSS and its subsystems including overviews and individual filter control screens. The ability to add, delete and modify custom screens shall be available to users with Supervisor access permissions.

G. History Logging: The system shall be capable of storing all data for at least 5 years of operation and stored data shall be available for multiple comparisons and reports.

H. GUI application customizations and dynamic logs must be contained in external data file(s). Dynamic logs at a minimum shall be defined as event logs and data logs. Data files shall conform to the following:

1. Adhere to the Extensible Markup Language (XML) 1.0 specification as published under the W3C® Recommendation status.
2. Support editing by Supervisor level users from the GUI's XML viewer.
3. Dynamic logs at the end of each month shall be automatically archived in a standard delimited format.

I. Report Generation - the GUI shall contain report generation wizards for the creation of custom reports and displaying historical data in either a tabular or graphical format. Any point or calculated variable will be available for trending.

J. The ACS vendor shall set up specific report generating software for all related LSS processes.

K. Alarm Management - the ACS shall be capable of generating alarms based on comparison of polled I/O data to limits or conditional equations configured in the GUI. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, reports, or initiating communication to another remote computing device. Alarm management features shall include:

1. Each alarm level will establish a unique set of parameters for controlling alarm display, acknowledgment, paging and logging.
2. Alarms shall be displayed on the main workstation and potentially to remote alarms (eg. lights, sirens) depending on type of alarm. All alarms will be sent to designated list of recipients in designated order until it is acknowledged. Once first person is notified, the system shall wait a set time for acknowledgement. If not acknowledged, then the alarm condition shall be sent to the next designated person. This routine shall continue until a person acknowledges alarm. System shall allow for up to 12 people on alarm list.
3. Paging shall be configured to send text alarms to wireless digital devices supporting e-mail, WCTP and/or TAP messaging.
4. Alarm Overrides: Provide ability to override alarms for set period of time. After which, alarm is automatically re-activated.
5. Print the alarm acknowledgment by password entrant.

8.4 SOFTWARE INSTALLATION

A. The Controls Supplier shall provide all labor necessary to install, initialize, start-up and debug all system software as described in this section. This includes any operating system software or other third-party software necessary for successful operation of the system.

8.5 DATABASE CONFIGURATION

A. The Controls Supplier will provide all labor to configure those portions of the database that are required by the points list and sequence of operation.

8.6 COLOR GRAPHICS

A. Unless otherwise directed by the owner, the Controls Supplier will provide color graphic displays as depicted in the LSS drawings for each system and display. For each system, the display

shall contain the associated points identified in the point list and allow for set point changes as required by the owner.

8.7 DOCUMENTATION

A. As built software documentation will include the following:

1. I/O points list.
2. Sequence of operation using descriptive prose.

    a. GRAPHICS
    b. DESCRIPTION

3. Submit final complete and verified listing of actual values for all factory and field configurable setpoints, PIP switch settings, etc., along with installed firmware and software revision information for all sensors, transmiters, variable frequency drives, etc.
4. Submit operation and maintenance data manuals for all equipments, including cut sheets for all components, trouble shooting guides, etc. In lieu of printed materials, the controls vendor may provide organized electronic folders linked to equipment manufacturer's websites.

B. DESCRPTION

1. Submit final complete and verified listing of actual values for all factory and field configurable setpoints, PIP switch settings, etc., along with installed firmware and software revision information for all sensors, transmitters, variable frequency drives, etc.
2. Submit operation and maintenance data manuals for all equipment, including cut sheets for all components, trouble shooting guides, etc. In lieu of printed materials, the controls vendor may provide organized electronic folders linked to equipment manufacturer's websites

8.8 RECIRCULATION SYSTEM DISPLAYS

A. There will a graphic display for each of the recirculation filters in the facility controlled by the ACS. The filter graphic will display current operational data, i.e. pump status, valve position, flow information, operational mode of the filter, enabled or disabled for backwash, basin water level(s) and any additional information that is available from the system database that is requested for display by the owner.

8.9 SYSTEM STATUS DISPLAY

A. There will a graphic display for each recirculation system, pretreatment systems, and outfall system, of all pertinent operational information for quick access by plant operator. The graphic will display flow, level, temperature, filter operation information and any additional information that is available from the system database that is requested for display by the owner.

8.10 GRAPHICAL OVERVIEW DISPLAY

A. There will a graphic display for all automated components pertinent to the operation of the system for quick access by plant operator. The graphic will display the data from the system database for quick reference by the operator nested in a graphic display of the systems.

8.11 TESTING AND COMMISSIONING

A. The ACS vendor shall provide system and commissioning to prove system functionality to the satisfaction of the Owner.

1. The ACS vendor shall be responsible for testing and adjusting the entire system for full functionality.
2. Testing shall include ACS response and recovery through artificially generated fault conditions, power failures, manual and automatic restarts to thoroughly test all functions and alarms. All systems shall be tested for power failures occurring at various points in the middle of process operations.
3. The ACS vendor shall operate the entire LSS continuously for not less than one full week (168 straight hours) without system malfunction prior to punchlist checkoff and acceptance by the Owner. Trending of all parameters must be setup and available for review at any time turning and following this test, for conformation that the system is performing as designed.

END OF SECTION

SECTION 210100 - BASIC FIRE PROTECTION REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. General Information Applying to all Division 21 Sections.
2. Scope of Work.
3. Substitution requests.
4. Submittals.
5. As-Built Drawings.
6. Operating and maintenance manuals.
7. Coordination.
8. Cutting and patching.
9. Access panels.
10. General electrical work.

1.3 GENERAL

A. Information specified in this section shall apply to all Division 21 specification sections.

B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to Division 21.

C. Contractor shall provide coordination drawings for Division 01.

D. Division 21 work shall be performed as outlined in “Information for Bidders”.

E. These specifications and the accompanying fire protection drawings are intended to provide for all labor, materials and equipment necessary for the installation of a complete

1. Wet-pipe sprinkler system.
2. Dry-pipe sprinkler system.

3. Accessories including necessary apparatus, valves, and fittings hereinafter described or called for on the Contract Documents.

F. All Division 21 work shall be installed in accordance with the following Codes and all Local Ordinances. Codes shall be latest editions approved by the NC Building Code Council with North Carolina amendments. Materials, equipment and workmanship shall be as specified throughout Division 21 specification sections.

1. North Carolina State Building Code.

2. North Carolina State Fire Prevention Code.

3. National Electric Code.

4. NFPA 13.

G. All products used as part of the installation of the fire sprinkler system shall be Underwriter's Laboratories (UL) or Factory Mutual (F.M.) approved as required by NFPA 13.

H. Contractor shall secure all required permits and inspection fees necessary for this work. Permits may be secured from the Building Inspections Department.

I. The Sprinkler Contractor shall provide the Owner with a one-year warranty for all sprinkler system labor, equipment, and all other work specified in the Division 21 specifications and fire protection Contract Drawings, including the work of the Sprinkler Contractor's subcontractors. Warranty period shall begin upon Substantial Completion.

1.4 SCOPE OF WORK

A. The Contractor shall be required to perform all the following work, in general and provide a complete fire sprinkler system(s) as shown on the plans. This Contractor's scope of work begins at the sprinkler riser rough-in(s) provided by others, approximately one foot above the finished floor. The items in general are to be as follows:

1. Furnish and install complete wet-pipe sprinkler system as shown on the fire protection drawings and here-in specified.

2. Furnish and install complete dry-pipe sprinkler system as shown on the fire protection drawings and here-in specified

1.5 BIDDING PROCEDURE

A. The Contractor shall provide bidding for Alternate Bids in accordance with Division 01. Contractor shall refer to Division 01 for any required unit prices and allowances.

1.6 SUBSTITUTION REQUESTS

A. The Sprinkler Contractor shall obtain written approval from the Engineer/Architect for the use of substitute materials claimed as equal to those specified. Substitution requests must be sent as soon after contract awards as possible and before any materials are ordered. Substitution requests are subject to deadlines posed by the Architect and/or Owner, as well as the requirements of Division 01.

B. Applications approval of substitutions shall be made by the Sprinkler Contractor and not by subcontractors or manufacturer representative.

C. Substitution requests shall be manufacturer's original published material.

D. Once the allowable period for substitution requests has ended, no further substitutions will be permitted except in unusual or extenuating circumstances.

1.7 SUBMITTALS

A. Submittals shall be sent to the Architect after the contract has been awarded and before any materials, fixtures, and equipment to be incorporated in the work has been ordered. Contractor is also required to submit shop drawings, hydraulic calculations, and materials submittal data as required below to the Authority Having Jurisdiction, including the NC State Construction Office.

B. Sprinkler system design submittal, including shop drawings, hydraulic calculations, and materials, shall be performed by a Professional Engineer registered in the State of North Carolina, or an individual who has Level III or IV certification from the National Institute for Certification in Engineering Technologies (NICET) in Fire Protection Engineering Technology: Water-Based Systems Layout in accordance with NICET 1014.

C. Shop Drawings:

1. The Sprinkler Contractor shall submit a set of installation plan drawings to the Architect before any materials, and equipment to be incorporated in the work has been ordered. **FAXED COPIES WILL NOT BE ACCEPTABLE**. Installation plan drawings shall include:

    a. Hydraulic design data, including remote area designation(s), and locations of nodes.

    b. All piping, included mains, cross mains, branches, and armovers with sizes indicated.

    c. Locations of couplings on grooved piping.

    d. Location of Riser(s).

    e. Riser Details.

    f. Hanger Details.

    g. U.L. Listed fire barrier penetration details.

    h. Locations of sprinkler heads.

    i. Sprinkler head legend, indicating the manufacturer, model number, temperature rating, and response characteristics of each type of sprinkler head.

    j. Location of existing fire department connection.

    k. Location of existing test header.

    l. Location of existing fire pump.

m. Location of inspector's test connection(s).

n. Location of auxiliary drains.

o. Site diagram indicating water supply piping location, sizes, and hydraulic calculation nodes.

p. Preparer's NICET Certification ID or Professional Engineer Seal.

q. Coordination Drawings per Division 1.

D. Hydraulic Calculations:

1. The Sprinkler Contractor shall submit a set of hydraulic calculations to the Architect before any materials, and equipment to be incorporated in the work has been ordered. Hydraulic Calculations shall be performed using computer-based software, such as HydraCALC or HASS. **FAXED COPIES WILL NOT BE ACCEPTABLE**. Hydraulic Calculations shall include:

a. Required water density and size of remote area(s), in accordance with NFPA and the Authority Having Jurisdiction.

b. Pressure and flow required for the system(s) to operate properly (after hose allowance has been added).

c. Pressure and flow available from reservoir.

d. Node by node analysis of required pressure, required flow, friction losses, and elevation.

e. Flow vs. pressure curves, indicating that sprinkler system curve(s) are sufficiently below supply curve.

E. Materials:

1. The Sprinkler Contractor shall submit a set of manufacturer's submittal data to the Architect before any materials, and equipment to be incorporated in the work has been ordered. **All sprinkler system components shall be UL listed and/or FM approved as required by NFPA 13.** Shop drawings shall include the name and address of the manufacturer and their catalog numbers and trade names clearly marked. All items shall be referenced to the specifications by **specification paragraph number on an index tab**. One complete set of submittal data shall be manufacturer's original published material. **FAXED COPIES WILL NOT BE ACCEPTABLE**. Approval of materials will be based upon the manufacturer's published ratings. Submit shop drawings and/or catalog data for the following material and equipment:

a. Sprinkler Heads.

b. Piping, Fittings, and Couplings.

c. Corrosion-resistant paint.

d. Valves.

e. Gauges.

f. Hangers.

g. Riser Check Valve.

h. Flow Switch.

i. Air Compressor.

j. Air Maintenance Device.

k. Nitrogen Generator.

l. UL Details.

m. Alarm/Control Panel for Water Reservoir.

2. Submittals shall include the name and address of the manufacturer and their catalog numbers and trade names clearly marked.

3. Submittal data shall be manufacturer's original published material.

F. If data submitted deviates from the contract documents, the Sprinkler Contractor shall point out such deviations in writing and also state reasons for same.

G. Review of materials will be based upon the manufacturer's published information.

H. Once submittals are reviewed and no exceptions are taken, no changes in materials will be permitted except in unusual or extenuating circumstances.

I. The Sprinkler Contractor shall review and stamp the submittals as being in accordance with his/her bid and the Contract Documents.

J. Prior to submitting information, the Sprinkler Contractor shall field verify all necessary dimensions to ensure that all items will fit within designated rooms and/or spaces with proper clearances.

K. Shop drawings and/or submittal review comments shall not relieve the Sprinkler Contractor of the responsibility to comply with the requirements and intent of the plans and specifications with regard to dimensions, capacities, quality, quantity, performance characteristics, etc.

1.8 OPERATING AND MAINTENANCE MANUAL

A. The Contractor shall deliver one complete set of bookmarked manuals in electronic PDF format to the Owner through the Designer, which shall include all operation and maintenance manuals, two (2) weeks before the pre-final inspection is held. The manuals shall be bookmarked to a minimum of one level – i.e.: each major piece of equipment (chiller, boiler switchboard, water closet, water heater, etc.) or document category (warranties, parts lists, contact information, etc.) The manuals shall be delivered by one of the following:

1. USB Drive

2. CD/DVD

3. Downloadable file from FTP Site

B. All operation and maintenance manuals **shall** be delivered by the Contractor to the Owner thru the Architect. The manuals **shall** contain the following items as a minimum:

1. Index and page numbers.
2. Sprinkler Contractor's signed one-year warranty.
3. Sprinkler Contractor's contact information.
4. List of subcontractors and suppliers with names, addresses, and phone numbers.
5. Backflow preventer certificate of operation and test reports.
6. All documented results of preliminary and system acceptance testing, including NFPA 13, NFPA 14, NFPA 20, and NFPA 24 forms, as applicable.
7. Submittal data and manufacturer's warranty info for all sprinkler heads, piping, hangers and supports, valves, flow switches, alarm bells, fire department connections, test headers, and each piece of equipment specified under Division 21.
8. Operation manuals, installation manuals, and parts list for all installed equipment.
9. Complete set of Sprinkler Contractor's record drawings and hydraulic calculations. Hydraulic calculations shall be updated to reflect any changes to system layout during installation, as applicable.
10. Copy of NFPA 25, edition to match that which is currently enforced by the Authority Having Jurisdiction.

C. ***FAXED COPIES WILL NOT BE ACCEPTABLE***.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

1.10 COORDINATION

A. Sprinkler Contractor shall be responsible to coordinate all work with the work of all other trades.

B. The Contractor shall coordinate with all other trades.

C. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for sprinkler system installation.

D. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

E. Coordinate requirements for access panels and doors for sprinkler system items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2. **MANUFACTURERS MODEL NUMBERS ARE PROVIDED FOR GENERAL INFORMATION ONLY.** Description of product shall take precedence over model numbers.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 21 Sections for pipe, tube, and fitting materials and joining methods.

2.3 JOINING MATERIALS

A. Refer to individual Division 21 Sections for joining materials.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 21 Sections.

B. The accompanying drawings are schematic only and are not intended to show all fittings, couplings, hangers, offsets, etc., unless specifically dimensioned. The layout shown on the drawings is a conceptual layout only. This contractor shall provide complete installation drawings for the sprinkler systems defined herein, per the Contract Drawings and these specifications. Provide all adjustments as necessary to conform to the structural conditions, machinery, equipment, work of other contractors and the intent of the drawings, without additional cost to the Owner. Fire protection consultant drawings should not be scaled. Secure dimensions from Architectural drawings. Refer to drawings of other trades and coordinate with other contractors. All equipment shall be installed in accordance with the manufacturer's published installation instructions and diagrams.

C. All cutting and patching shall be in accordance with Division 01.

D. Furnish and install all necessary sleeves, inserts, bolts, etc., for concrete floor slabs, roof, walls, and partitions. Failure to install such items in time to avoid delaying the project schedule shall result in the Sprinkler Contractor doing all cutting and repairing at his/her own expense.

E. All equipment shall be installed in accordance with manufacturer's written installation instructions.

F. All equipment shall be installed such that components do not provide a safety hazard to occupants who come within a close proximity.

G. The Sprinkler Contractor shall provide access doors in accordance with Division 08 of these specifications. Access doors shall be provided for all valves located behind hard ceilings and in walls to provide access. Ceiling access doors shall be stainless steel and a minimum of 24" x 24". All access panels shall be labeled with a metal sign indicating what is behind the access panel. Sign shall have white background with red letters.

H. The Sprinkler Contractor shall be responsible for all work damaged by him or her. Any fire sprinkler system work damaged by any other contractor shall be replaced by the Sprinkler Contractor and placed in perfect working condition without extra cost to the Owner. All sprinkler heads, valves, pipe, fittings, and equipment shall be adequately protected before, during and after installation.

I. The Contractor shall be responsible for all sprinkler heads, valves, pipe, fittings, and equipment at time of final inspection. Any broken items will be replaced by the Contractor at no cost to the owner regardless of by whom the item was broken.

J. The Sprinkler Contractor, shall maintain a set of the Engineer's Contract Drawings marked up to show the work as installed. Contractor shall initial and date all changes to the approved shop drawings. The Architectural Observer may check this set of documents monthly for compliance. Upon completion of the work, Sprinkler Contractor shall use these as-built drawings to create a set of record drawings which shall be delivered to the Architect.

3.2 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Wet and Dry Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.3 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment and piping to allow maximum possible headroom unless specific mounting heights are indicated.

B. Install piping level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install sprinkler system components to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations.

3.4 ELECTRICAL WIRING

A. Equipment and valve connections to alarm and/or signaling systems, including but not limited to wiring of flow switches, pressure switches, and tamper switches, shall be provided by Fire Alarm Contractor.

B. Power to Air Compressor, Nitrogen Generator, and any other equipment provided by Division 21 shall be provided by the Electrical Contractor.

3.5 PLACING IN SERVICE

A. Upon completion of the entire system installation, the entire system and all equipment shall be tested as described in individual Division 21 specification sections to ensure that it will function as intended.

B. The Sprinkler Contractor shall furnish Owner’s representative with Contractor’s Material and Test Certificate, per NFPA.

C. The Sprinkler Contractor shall place the entire system in a satisfactory operating condition and shall furnish all assistance and instructions required by the Owner's representative during initial operating period.

D. The Sprinkler Contractor shall provide a hard copy of final record drawings and final hydraulic calculations in a closed tube located in the main sprinkler riser room.

END OF SECTION 210100

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SECTION 210517 - SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Grout.
3. Sealants.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, with plain ends.

B. Pipe sleeves located in areas that are indicated on the Contract Drawings to be “Corrosion Resistant” shall be field painted using marine grade paint designed by the manufacturer for protecting metal surfaces from corrosion. Paint color by architect.

2.2 GROUT

A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.3 SEALANTS

A. Watertight sealants as manufactured by Holdrite, Proset, Metacaulk, or 3M.

2.4 FIRE/SMOKE BARRIER PENETRATION SYSTEMS

A. Provide U.L. listed systems by Metacaulk, 3M, or Hilti.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in **ALL** floors, partitions, roofs, and walls.

B. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas **2 inches** above finished floor level.

2. Using **grout**, seal space outside of sleeves in slabs and walls without sleeve-seal system.

C. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.

2. Seal with watertight sealant.

D. Pipe sleeves shall be two pipe sizes larger than piping passing through the sleeve.

E. Install sleeves concentric and centered on pipes.

F. Ream all sleeves to prevent cutting of piping.

G. Core drill openings for all floor openings may be utilized in lieu of sleeved openings. All openings shall be sized two pipe sizes larger than pipe passing thru the opening. All cored openings shall be fireproofed as required and shall be made water tight.

H. All openings through floors shall be protected by watertight sealant.

I. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: All penetrations in rated floors, firewalls and any other rated separations shall be protected using a through-penetration firestopping method with an “F” rating equivalent to the rating of the membrane being penetrated for particular piping materials used and membrane construction type. Floor penetrations shall additionally have a “T” rating equivalent to the rating of the floor being penetrated. Through–penetration firestop systems shall be installed and tested in accordance with ASTM E814 or UL 1479 with a minimum positive pressure differential 0.01 inch w.g. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping." All openings through horizontal fire separations shall be protected by U.L. listed systems.

3.2 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Concrete Slabs above Grade:

a. Steel pipe sleeves.

2. Interior Partitions:

a. Steel Pipe Sleeves.

END OF SECTION 210517

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SECTION 210518 - ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished, chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.

D. Split-Casting, Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.

E. Escutcheons that are noted on the Contract Drawings as “Corrosion Resistant” shall have factory-applied corrosion resistant coating.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast iron flange with holes for fasteners.

B. Floor plates that are noted on the Contract Drawings as “Corrosion Resistant” shall have factory-applied corrosion resistant coating.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons snug against room finish.

C. Install escutcheons with ID to closely fit around pipe and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.

b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece cast brass or split-casting brass type with polished, chrome-plated finish.

c. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stamped steel type.

d. Bare Piping in Unfinished Service Spaces: One-piece cast brass or split-casting brass type with polished, rough-brass finish.

e. Bare Piping in Equipment Rooms: One-piece cast brass or split-casting brass type with polished, rough-brass finish.

D. Install floor plates for piping penetrations of equipment-room floors.

E. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor plate.

3.2 FIELD QUALITY CONTROL

A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION 210518

SECTION 210553 - IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Riser Placards.
3. Fire Pump Testing Placards.
4. Zone Coverage Information.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment, Control Valves, Main Drain:

1. Letter Color: Red.
2. Background Color: White.
3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
4. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
5. Fasteners: Stainless-steel rivets or self-tapping screws, or chain.
6. Adhesive: Not permitted.

B. Metal Riser Placard:

1. Letter Color: White (information shall be filled in by Sprinkler Contractor with Black Letters).

2. Background Color: Red.

3. Fasteners: Stainless-steel rivets or self-tapping screws, or chain.

4. Adhesive: Not permitted.

5. Each placard shall contain the following data:

    a. Location of area protected by riser.

    b. Total number of sprinkler heads connected to riser.

    c. Design density and design area, as approved.

    d. Required flow rate and pressure at the base of the riser, as approved.

C. Fire Pump Testing Placard:

1. Letter Color: White (information shall be filled in by Sprinkler Contractor with Black Letters).

2. Background Color: Red.

3. Fasteners: Stainless-steel rivets or self-tapping screws, or chain.

4. Adhesive: Not permitted.

5. Each placard shall contain the following data:

    a. Minimum suction pressure that the fire pump is allowed to be tested at (30 psi per the local water utility).

    b. Required flow rate at the minimum suction pressure.

D. Zone Coverage Information:

1. Sprinkler Contractor shall provide floor plans with areas affected by each sprinkler system zone valve indicated by highlighting, shading, hatching, or outlines.. Floor plans shall be individually framed below glass and mounted in sprinkler riser room.

PART 3 - EXECUTION

3.1 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of equipment, control valves, main drain, auxiliary drains, and inspectors test connections.

B. Locate labels where accessible and visible.

C. Locate adhesive label on ceiling grid below valves or auxiliary drains located above ceilings. Label shall describe the item above (i.e. “AUXILIARY DRAIN”). Letter height shall be per ANSI.

3.2 PLACARD INSTALLATION

A. Each individual riser shall be marked with a metal hydraulic placard.

B. Fire Pump Testing placard shall be located on the wall in a visible location near the fire pump.

END OF SECTION 210553

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SECTION 211313 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Specialty valves.
3. Sprinklers.
4. Alarm devices.
5. Pressure gages.

1.3 ACTION SUBMITTALS

A. Sprinkler Contractor shall provide delegated design submittals, including materials, shop drawings, and hydraulic calculations, as indicated in Section 210100 “Basic Fire Protection Requirements.”

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench for each type of sprinkler used on Project.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13.

2. All components shall be listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide." for the proposed application, as required by NFPA 13.

B. Piping system components shall be listed for 300-psig minimum working pressure.

C. Delegated Design: Engage a qualified professional engineer, as defined in Section 210100 "Basic Fire Protection Requirements," to design wet-pipe sprinkler systems.

1. Sprinkler system design shall be approved by authorities having jurisdiction.

a. Sprinkler Occupancy Hazard Classifications: As indicated on Contract Drawings.

2. Minimum Density for Automatic-Sprinkler Piping Design: Per NFPA 13 and as indicated on Contract Drawings.

3. Maximum Protection Area per Sprinkler: Per NFPA 13, Contract Drawings, and in accordance with listings of sprinkler heads.

2.2 STEEL PIPE AND FITTINGS

A. Schedule 40, Black Steel Pipe: ASTM A 795 and ANSI/ASTM A 53. Pipe ends may be factory or field formed to match joining method.

B. Schedule 10, Black-Steel Pipe: ASTM A 795 and ANSI/ASTM A 53.

C. Fittings for threaded black steel piping shall be cast iron threaded fittings by Anvil or Viking.

D. Fittings for grooved black steel piping shall be ductile iron grooved fittings conforming to ASTM A 536. Fittings shall be Victaulic “Firelock” joined with Victaulic “Firelock” rigid ductile iron couplings or approved equal by Grinnell or Reliable.

E. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

F. Pipe, fittings, and couplings indicated on the Contract Drawings to be “Corrosion Resistant” shall be field painted using marine grade paint designed by the manufacturer for protecting metal surfaces from corrosion. Paint color by architect.

2.3 HANGERS

A. Hangers for vertical piping shall be Riser Clamp design and shall be by Afcon, Viking, or Anvil.

1. Hangers located in areas designated on the Contract Drawings to be “Corrosion Resistant” shall be stainless steel.

B. Hangers for horizontal piping shall be hanger rings attached to top beam clamps using 3/8” threaded rod. Provide Afcon, Viking, or Anvil.

1. In areas with concrete beams fasteners designed for concrete may be used instead of top beam clamps.

2. Hangers, beam clamps, fasteners, and threaded rod located in areas designated on the Contract Drawings to be “Corrosion Resistant” shall be stainless steel.

2.4 SPECIALTY VALVES

A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

B. Pressure Rating:

1. 300-psig minimum, unless otherwise noted.

C. Body Material: Cast or ductile iron.

D. Size: Same as connected piping.

E. End Connections: Flanged or grooved.

F. Riser Check Valves:

1. Reliable Model G, or approved equal by Tyco or Victaulic

2. Design: For vertical installation.

3. Features: Grooved connections, rated for 250 psi, with upstream and downstream pressure gauges, and main drain valve piped to exterior of the building.

G. Control Valves shall be ductile iron butterfly valves.

1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.

2. Minimum Pressure Rating: 300 psig.

3. Body Material: Ductile iron with nylon, EPDM, epoxy, or polyamide coating.

4. Seat Material: EPDM.

5. Stem: Stainless steel.

6. Disc: Ductile iron.

7. Actuator: Worm gear or traveling nut.

8. Supervisory Switch: Internal or external.

9. Body Design: Grooved-end connections.

H. Trim and Drain Valves:

1. Type: Ball valve

2. Minimum Pressure Rating: 300 psig.

3. Body Material: Forged Brass of Bronze.

4. Actuator: Hand Lever.

5. End connections: Threaded.

I. Valves not specified elsewhere in Division 21 shall be UL listed and/or FM approved as required by NFPA 13, and shall be listed specifically for fire protection service.

2.5 SPRINKLER PIPING SPECIALTIES

A. Flow Switch:

1. Description: Electric vane-type water flow alarm switch. Activation shall be accomplished by the continuous flow of water against a non-corrosive paddle attached to a non-corrosive stem operating a field replaceable instantly recycling adjustable retard with a 0-90 second range and visual indication of activation. Expiration of the retard time shall result in the simultaneous operation of two sets of single pole double throw (SPDT) switch contacts rated at 10A, 125VAC and 2A, 30VDC. Each switch contact shall have a separate wiring chamber and separate conduit entrance to comply with the separation of power limited and non-power limited conductors without the need for special wire or wire methods.

2. Potter (Viking) VSR or approved equal by System Sensor or Tyco.

3. Pressure Rating: Up to 450 psi.

4. Maximum Water Surge Listing: 18 fps.

5. Alarm Activation Flow: 10 gpm maximum.

6. Features: U bolt and saddle with non-corrosive insert for mounting to the pipe, a non-corrosive vane and trip stem assembly for detecting waterflow, and a retard time delayed switch to prevent false alarms from water surges. It shall be possible to install an optional cover tamper switch to detect removal of the enclosure.

7. Enclosure: NEMA 4 rated, held captive by tamper resistant screws.

2.6 SPRINKLERS

A. Sprinkler heads shall be listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide." for the proposed application.

B. Sprinkler head types shall be as indicated on the Contract Drawings.

C. All sprinkler heads shall be quick response type, unless otherwise indicated on the Contract Drawings.

D. All sprinkler heads shall be glass bulb type.

E. Sprinkler heads shall have ordinary temperature classification, unless otherwise indicated on the Contract Drawings, or required by NFPA 13.

F. K-Factor of sprinkler heads shall be 5.6, 8.0, or 11.2.

G. Sprinklers that are noted on the Contract Drawings as “Corrosion Resistant” shall be factory coated with Victaulic VC-250 or Tyco Poly-Stainless. Escutcheons shall also have factory-applied corrosion resistant coating.

2.7 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Valve Supervisory Switches:

1. Standard: UL 346.

2. Type: Electrically supervised.

3. Components: Single-pole, double-throw switch with normally closed contacts.

4. Design: Signals that controlled valve is in other than fully open position.

5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.8 PRESSURE GAGES

A. Standard: UL 393.

B. Dial Size: 3-1/2- to 4-1/2-inch diameter.

C. Pressure Gage Range: 0- to 250-psig.

PART 3 - EXECUTION

3.1 SERVICE-ENTRANCE PIPING

A. Install per Contract Drawings and Division 21 specifications.

3.2 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of sprinkler main piping. Install piping as indicated on approved shop drawings.

1. Deviations from approved shop drawings for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.

C. All piping shall be NPS 1 or larger.

D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install unions adjacent to each valve in pipes NPS 2 and smaller.

F. Install couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

H. Piping shall be installed level, without slope, unless otherwise indicated on Contract Drawings.

1. Exception: Piping installed immediately below sloped roofs shall match the slope of the roof.

I. Install sprinkler piping with drains for complete system drainage.

1. Exception: Trapped water in the amount of 5 gallons or less is acceptable per NFPA 13. The amount of trapped water in the system shall be minimized.

J. Install all piping as directly as possible, avoiding unnecessary bends and turns so as not to interfere with proper installation of work of other Divisions.

K. All piping shall be routed with a minimum clearance of ten (10) feet from any electrical switchboards, panel boards or telephone backboards.

L. Piping shall be concealed in walls, or above ceilings, unless otherwise indicated on Contract Drawings.

1. No sprinkler piping shall be covered or concealed until inspected by the Authority Having Jurisdiction.

M. Piping shall not be installed underground.

N. Install alarm devices in piping systems.

O. Alarm bell shall be surface mounted on exterior of building.

P. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

Q. Support horizontal black steel pipe with hangers located every 12 feet for piping 1-1/4” or smaller and every 15 feet for all piping 1-1/2” or larger.

R. Armovers longer than 24” shall be supported by hangers per NFPA 13.

S. Top beam clamps shall only be attached to the top portion of structural members. All hangers shall permit adequate adjustment after erection while still supporting the load.

T. Trapeze hangers are allowed only where it is necessary due to the required piping layout and structure.

U. Trapeze hangers shall attach to the structure using top beam clamps located on both sides of trapeze hanger. Top beam clamps shall only be attached to the top portion of structural members.

V. Hangers **SHALL NOT** be fastened to joist bridging or roof deck.

W. Hangers shall only be hung with drilling into the slab with drop-in anchors or with concrete screws into concrete beams with the approval of the Structural Engineer of record. Sprinkler Contractor shall provide complete dead and operating load information for each location.

X. Install pressure gages on riser or feed main, and at each sprinkler test connection. Include pressure gages with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.

Y. Fill sprinkler system piping with water.

Z. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

AA. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

BB. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.3 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

D. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

F. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

3.4 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections.

C. Specialty Valves:

1. Install valves in vertical position for proper direction of flow, in main supply to system.

3.5 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of ceiling tiles.

B. Sprinkler heads shall be installed on armovers to allow their locations to be adjusted to the center of ceiling tiles.

C. Sprinkler heads may be installed using flexible sprinkler hose fittings. Install hose into bracket on ceiling grid.

D. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

3.6 IDENTIFICATION

A. Install labeling on components according to requirements in NFPA 13.

B. Install hydraulic placard on each riser.

3.7 FIELD QUALITY CONTROL

A. All equipment and components located on site shall be protected from the weather and damage from construction equipment.

B. The Contractor shall notify the Engineer forty-eight (48) hours in advance of all tests. The Contractor shall make all necessary preliminary tests to ensure a functional system, which shall include flushing, testing, and inspection of sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.

C. All tests shall be applied before any work is concealed or covered in any manner.

D. All tests shall be conducted with regard to safety of all personnel on site.

E. The Authority Having Jurisdiction shall be alerted to and invited to witness all Division 21 tests.

F. Preliminary Tests:

1. All sprinkler piping shall be made tight under a hydrostatic test pressure of 50 psi greater than the required design pressure, or 200 psi, whichever is greater. Hydrostatic test pressure shall be maintained without pressure loss for a minimum of two (2) hours. No

caulking of joints will be permitted. Test pressure shall be read from a gauge located at the low elevation point of the system that is under test pressure. Any joint found to leak under this test shall be broken, remade and a new test applied.

2. Waterflow detecting devices, including associated alarm circuits, shall be flow tested using the inspector's test connection. Alarm bell must be audible on premises within five (5) minutes of fully opening inspector's test connection. Each water-operated alarm device shall be tested to verify proper operation.

3. Each tamper switch shall be tested by operating the associated valve.

4. Following flushing of the underground piping, a main drain test shall be made to verify the adequacy of the water supply. Static and residual pressures shall be recorded and submitted. In addition, a main drain test shall be conducted each time after a main control valve is shut and opened.

5. Energize circuits to electrical equipment and devices.

6. Verify that equipment hose threads are same as local fire department equipment.

7. Main drain valves shall be opened until the system pressure stabilizes.

8. All control valves shall be fully opened and closed under system water pressure to ensure proper operation.

9. All alarms, supervisory signals, and trouble signals that are related to the sprinkler system shall be activated and verified.

G. A final acceptance test shall be conducted, only after all above tests have been successfully conducted and reports have been submitted and approved, in which a technician employed by the installing Sprinkler Contractor shall provide a complete demonstration of the operation of the system. This demonstration shall include operation of control valves and flowing of inspector's test connections to verify operation of associated waterflow alarm switches, as well as a subsequent main drain test to verify that the control valves are in the open position. The technician shall have a copy of all "as-built" drawings, as well as certificates of previously conducted tests listed above. The sprinkler system installation shall not be considered accepted until as identified problems have been corrected, and the system is successfully retested. It is also required that the test documentation is properly completed and received prior to system acceptance.

H. Prior to making a request of Beneficial Occupancy the Sprinkler Contractor shall submit written test reports and certificates as required by NFPA 13 and 24. Submittals shall include system acceptance forms copyrighted by NFPA which shall bear the NFPA copyright symbol. No other forms shall be considered.

I. Sprinkler piping system will be considered defective if it does not pass tests and inspections. Replace damaged and malfunctioning controls and equipment, and retest as necessary.

J. The Contractor shall furnish all necessary equipment, materials and labor to perform the above-specified tests. All equipment and materials shall be in excellent condition.

K. Prepare test and inspection reports.

3.8 CLEANING

A. Clean dirt and debris from sprinklers.

B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain wet pipe sprinkler system.

3.10 PIPING SCHEDULE

A. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be the following:

1. Schedule 40 black steel pipe with threaded ends, cast iron fittings, and threaded joints.

B. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 and larger, shall be the following:

1. Schedule 10 black steel pipe with roll-grooved ends, ductile iron fittings, and grooved joints.

3.11 SPRINKLER SCHEDULE

A. Per Contract Drawings.

END OF SECTION 211313

SECTION 211316 - DRY-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Specialty valves.
3. Nitrogen Generator.
4. Air Compressor.
5. Sprinklers.
6. Pressure gages.

1.3 ACTION SUBMITTALS

A. Sprinkler Contractor shall provide delegated design submittals, including materials, shop drawings, and hydraulic calculations, as indicated in Section 210100 “Basic Fire Protection Requirements.”

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For dry-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench for each type of sprinkler used on Project.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13.

2. All components shall be listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide." for the proposed application, as required by NFPA 13.

B. Piping system components shall be listed for 300-psig minimum working pressure.

C. Delegated Design: Engage a qualified professional engineer, as defined in Section 210100 "Basic Fire Protection Requirements," to design wet-pipe sprinkler systems.

1. Sprinkler system design shall be approved by authorities having jurisdiction.

a. Sprinkler Occupancy Hazard Classifications: As indicated on Contract Drawings.

2. Minimum Density for Automatic-Sprinkler Piping Design: Per NFPA 13 and as indicated on Contract Drawings.

3. Maximum Protection Area per Sprinkler: Per NFPA 13, Contract Drawings, and in accordance with listings of sprinkler heads.

2.2 STEEL PIPE AND FITTINGS

A. Schedule 40, Black Steel Pipe: ASTM A 795 and ANSI/ASTM A 53. Pipe ends may be factory or field formed to match joining method.

B. Schedule 10, Black-Steel Pipe: ASTM A 795 and ANSI/ASTM A 53.

C. Fittings for threaded black steel piping shall be cast iron threaded fittings by Anvil or Viking.

D. Fittings for grooved black steel piping shall be ductile iron grooved fittings conforming to ASTM A 536. Fittings shall be Victaulic “Firelock” joined with Victaulic “Firelock” rigid ductile iron couplings or approved equal by Grinnell or Reliable.

E. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

F. Pipe, fittings, and couplings indicated on the Contract Drawings to be “Corrosion Resistant” shall be field painted using marine grade paint designed by the manufacturer for protecting metal surfaces from corrosion. Paint color by architect.

2.3 HANGERS

A. Hangers for vertical piping shall be Riser Clamp design and shall be by Afcon, Viking, or Anvil.

1. Hangers located in areas designated on the Contract Drawings to be “Corrosion Resistant” shall be stainless steel.

B. Hangers for horizontal piping shall be hanger rings attached to top beam clamps using 3/8" threaded rod. Provide Afcon, Viking, or Anvil.

1. In areas with concrete beams fasteners designed for concrete may be used instead of top beam clamps.

2. Hangers, beam clamps, fasteners, and threaded rod located in areas designated on the Contract Drawings to be "Corrosion Resistant" shall be stainless steel.

2.4 SPECIALTY VALVES

A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

B. Pressure Rating:

1. 300-psig minimum, unless otherwise noted

C. Body Material: Cast or ductile iron.

D. Size: Same as connected piping.

E. End Connections: Flanged or grooved.

F. Control Valves shall be ductile iron butterfly valves.

1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.

2. Minimum Pressure Rating: 300 psig.

3. Body Material: Ductile iron with nylon, EPDM, epoxy, or polyamide coating.

4. Seat Material: EPDM.

5. Stem: Stainless steel.

6. Disc: Ductile iron.

7. Actuator: Worm gear or traveling nut.

8. Supervisory Switch: Internal or external.

9. Body Design: Grooved-end connections.

G. Trim and Drain Valves:

1. Type: Ball valve

2. Minimum Pressure Rating: 300 psig.

3. Body Material: Forged Brass of Bronze.

4. Actuator: Hand Lever.

5. End connections: Threaded.

H. Valves not specified elsewhere in Division 21 shall be UL listed and/or FM approved as required by NFPA 13, and shall be listed specifically for fire protection service.

2.5 NITROGEN GENERATOR

A. South-Tek, General Air Products, Potter, Tyco.

B. Sized by Contractor based on combined volume of all connected dry systems.

C. Floor mounted with integral controls.

D. Dry contacts for “common alarm” and “bypass” alarm to allow remote monitoring by fire alarm panel.

E. May be factory installed in same cabinet as air compressor.

2.6 AIR COMPRESSOR

A. South-Tek, General Air Products, Potter, Tyco.

B. Sized by Contractor based on the largest connected dry system volume.

C. Floor mounted with vertical tank.

D. Include air pressure maintenance device.

E. May be factory installed in same cabinet as nitrogen generator.

2.7 SPRINKLERS

A. Sprinkler heads shall be listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide." for the proposed application.

B. Sprinkler head types shall be as indicated on the Contract Drawings.

C. All sprinkler heads shall be quick response type, unless otherwise indicated on the Contract Drawings.

D. All sprinkler heads shall be glass bulb type.

E. Sprinkler heads shall have ordinary temperature classification, unless otherwise indicated on the Contract Drawings, or required by NFPA 13.

F. K-Factor of sprinkler heads shall be 5.6, 8.0, or 11.2.

G. Sprinklers that are noted on the Contract Drawings as “Corrosion Resistant” shall be factory coated with Victaulic VC-250 or Tyco Poly-Stainless. Escutcheons shall also have factory-applied corrosion resistant coating.

2.8 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Pressure Switches:

1. Standard: UL 346.

2. Type: Electrically supervised water-flow switch with retard feature.

3. Components: Single-pole, double-throw switch with normally closed contacts.

4. Design Operation: Rising pressure signals water flow.

C. Valve Supervisory Switches:

1. Standard: UL 346.

2. Type: Electrically supervised.

3. Components: Single-pole, double-throw switch with normally closed contacts.

4. Design: Signals that controlled valve is in other than fully open position.

5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application

2.9 PRESSURE GAGES

A. Standard: UL 393.

B. Dial Size: 3-1/2- to 4-1/2-inch diameter.

C. Pressure Gage Range: 0- to 250-psig.

PART 3 - EXECUTION

3.1 SERVICE-ENTRANCE PIPING

A. Install per Contract Drawings and Division 21 specifications.

3.2 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of sprinkler main piping. Install piping as indicated on approved shop drawings.

1. Deviations from approved shop drawings for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.

C. All piping shall be NPS 1 or larger.

D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install unions adjacent to each valve in pipes NPS 2 and smaller.

F. Install couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

H. Piping shall be installed with slopes to drains. Slopes shall be as indicated on Contract Drawings.

I. Install sprinkler piping with drains for complete system drainage.

J. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

K. Connect compressed-air supply to dry-pipe sprinkler piping.

L. Connect air compressor to the following piping and wiring:

1. Pressure gages and controls.

2. Electrical power system.

3. Fire-alarm devices, including low-pressure alarm.

M. Install air compressor and nitrogen generator with minimum clearances required by the manufacturer(s).

N. Install all piping as directly as possible, avoiding unnecessary bends and turns so as not to interfere with proper installation of work of other Divisions.

O. All piping shall be routed with a minimum clearance of ten (10) feet from any electrical switchboards, panel boards or telephone backboards.

P. Piping shall be concealed in walls, or above ceilings, unless otherwise indicated on Contract Drawings.

1. No sprinkler piping shall be covered or concealed until inspected by the Authority Having Jurisdiction.

Q. Piping shall not be installed underground.

R. Install alarm devices in piping systems.

S. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

T. Support horizontal black steel pipe with hangers located every 12 feet for piping 1-1/4” or smaller and every 15 feet for all piping 1-1/2” or larger.

U. Armovers longer than 24” shall be supported by hangers per NFPA 13.

V. All hangers shall permit adequate adjustment after erection while still supporting the load.

W. Trapeze hangers are allowed only where it is necessary due to the required piping layout and structure.

X. Trapeze hangers shall attach to the structure on both sides of trapeze hanger.

Y. Hangers **SHALL NOT** be fastened to joist bridging or roof deck.

Z. Install pressure gages on riser or feed main, and at each sprinkler test connection. Include pressure gages with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.

AA. Drain dry-pipe sprinkler piping.

BB. Pressurize and check dry-pipe sprinkler system piping and air-pressure maintenance devices and air compressor.

CC. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

DD. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

EE. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.3 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

D. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

F. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

3.4 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections.

C. Specialty Valves:

1. Install valves in vertical position for proper direction of flow, in main supply to system.

2. Install dry-pipe valves with trim sets for air supply, drain, alarm connections, and pressure gages.

a. Install air compressor and compressed-air-supply piping.

b. Install air-pressure maintenance device with shutoff valves to permit servicing without shutting down sprinkler system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with 14- to 60-psig adjustable range; and 175-psig maximum inlet pressure.

3.5 SPRINKLER INSTALLATION

A. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall sprinklers in areas subject to freezing.

3.6 IDENTIFICATION

A. Install labeling on components according to requirements in NFPA 13.

B. Install hydraulic placard on each riser.

3.7 FIELD QUALITY CONTROL

A. All equipment and components located on site shall be protected from the weather and damage from construction equipment.

B. The Contractor shall notify the Engineer forty-eight (48) hours in advance of all tests. The Contractor shall make all necessary preliminary tests to ensure a functional system, which shall include flushing, testing, and inspection of sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.

C. All tests shall be applied before any work is concealed or covered in any manner.

D. All tests shall be conducted with regard to safety of all personnel on site.

E. The Authority Having Jurisdiction shall be alerted to and invited to witness all Division 21 tests.

F. Preliminary Tests:

1. All sprinkler piping shall be made tight under a hydrostatic test pressure of 50 psi greater than the required design pressure, or 200 psi, whichever is greater. Hydrostatic test pressure shall be maintained without pressure loss for a minimum of two (2) hours. No caulking of joints will be permitted. Test pressure shall be read from a gauge located at the low elevation point of the system that is under test pressure. Any joint found to leak under this test shall be broken, remade and a new test applied.

2. Dry sprinkler systems shall also be subjected to an air pressure leakage test at 40 psi for a minimum of twenty-four (24) hours.

3. Waterflow detecting devices, including associated alarm circuits, shall be flow tested using the inspector’s test connection. Alarm bell must be audible on premises within five (5) minutes of fully opening inspector’s test connection. Each water-operated alarm device shall be tested to verify proper operation.

4. Each tamper switch shall be tested by operating the associated valve.

5. Following flushing of the underground piping, a main drain test shall be made to verify the adequacy of the water supply. Static and residual pressures shall be recorded and submitted. In addition, a main drain test shall be conducted each time after a main control valve is shut and opened.

6. Energize circuits to electrical equipment and devices.

7. Verify that equipment hose threads are same as local fire department equipment.

8. Dry pipe valves shall be tested using the inspector’s test connection. The time it takes for the dry pipe valve to trip, as well as the time it takes for water to flow from the inspector’s test connection after inspector’s test connection is fully opened shall be measured.

9. Main drain valves shall be opened until the system pressure stabilizes.

10. All control valves shall be fully opened and closed under system water pressure to ensure proper operation.

11. All alarms, supervisory signals, and trouble signals that are related to the sprinkler system shall be activated and verified.

G. A final acceptance test shall be conducted, only after all above tests have been successfully conducted and reports have been submitted and approved, in which a technician employed by the installing Sprinkler Contractor shall provide a complete demonstration of the operation of the system. This demonstration shall include operation of control valves and flowing of inspector's

test connections to verify operation of associated waterflow alarm switches, as well as a subsequent main drain test to verify that the control valves are in the open position. The technician shall have a copy of all “as-built” drawings, as well as certificates of previously conducted tests listed above. The sprinkler system installation shall not be considered accepted until as identified problems have been corrected, and the system is successfully retested. It is also required that the test documentation is properly completed and received prior to system acceptance.

H. Prior to making a request of Beneficial Occupancy the Sprinkler Contractor shall submit written test reports and certificates as required by NFPA 13 and 24. Submittals shall include system acceptance forms copyrighted by NFPA which shall bear the NFPA copyright symbol. No other forms shall be considered.

I. Sprinkler piping system will be considered defective if it does not pass tests and inspections. Replace damaged and malfunctioning controls and equipment, and retest as necessary.

J. The Contractor shall furnish all necessary equipment, materials and labor to perform the above-specified tests. All equipment and materials shall be in excellent condition.

K. Prepare test and inspection reports.

3.8 CLEANING

A. Clean dirt and debris from sprinklers.

B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain wet pipe sprinkler system

3.10 PIPING SCHEDULE

A. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be the following:

1. Schedule 40 black steel pipe with threaded ends, cast iron fittings, and threaded joints.

B. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 and larger, shall be the following:

1. Schedule 10 black steel pipe with cut-grooved ends, ductile iron fittings, and grooved joints.

3.11 SPRINKLER SCHEDULE

A. Per Contract Drawings

END OF SECTION 211316

SECTION 220000 - GENERAL PLUMBING

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials and equipment and incidentals required to make ready for use complete plumbing systems as shown on the Drawings and specified herein.

B. Where Sub-Contracts are used to perform portions of the work, division of labor between sub trades is the responsibility of the Contractor.

C. Furnish all labor, materials and equipment and incidentals required to make ready for use complete plumbing systems as shown on the Drawings and specified herein.

D. Work includes furnishing, installing and testing the equipment and materials specified in other sections of the Division Specifications and shown on the Plumbing Drawings. It is the intent of these Specifications that the plumbing systems shall be suitable in every way for the intended usage. All material and all work which may be reasonably implied as being incidental to the work of this Division shall be furnished at no extra cost.

E. The general scope work includes, but is not limited to, furnishing, coordinating, and installing the following.

1. Domestic waste and vent systems with connection to site utilities.
2. Domestic water distribution systems with connection to site utilities.
3. Roof drainage systems with connections to site utilities.
4. Plumbing fixtures, specialties and equipment.

F. Visit all areas of the existing site, buildings and structures (as applicable) in which work under these sections is to be performed. Inspect carefully the existing conditions prior to bidding. Bid submission is evidence that the Contractor has examined the site and existing conditions, understands conditions under which the work will be performed, and takes full responsibility for complete knowledge of all factors governing the work.

G. Schedule all service interruptions in existing facilities at the Owner's convenience with 24 hours (minimum) notice. Obtain prior approval for each interruption.

H. Thoroughly test all plumbing systems after installation and make any minor corrections, changes or adjustments necessary for proper functioning of the systems and equipment. All workmanship shall be of the highest quality; substandard work will be rejected.

1.2 SUBMITTALS

A. Procedures for submittals: Submit under provisions of relevant sections of the General and Supplemental General Conditions and Division 01 Specifications Sections.

Transmit each shop drawing submittal with provided Shop Drawing Submittal Cover Form, attached herewith for each item of equipment/material or each specification section/paragraph.

B. Clearly indicate proposed equipment and/or materials substitutions in shop drawings. Summarize all deviations from the specified quality, functionality, appearance or performance of proposed equipment and/or materials in the preface of each submittal. Include documentation to support deviations.

C. Provide descriptive data on all materials and equipment as required to ascertain compliance with Specifications.

D. The design layout shown on drawings is based on physical sizes of reputable equipment manufacturers. If equipment other than the models indicated is installed, any resulting conflicts with space, maintenance access, clearances or codes are the responsibility of the Contractor to correct at his expense.

E. Where specific models and manufacturers of materials and equipment are specified, substitutions as allowed by the specifications and State law will be considered. Substitutions must be equivalent in quality, function, suitability and arrangement to specified equipment. Architect/Engineer to have final authority as to equivalency of substitutions.

F. Equipment model numbers noted in these specifications or in the drawings are intended to establish a minimum standard of quality and do not necessarily relate to specific options or arrangements as shown. Provide equipment with all standard features and optional features as stated and arranged as shown on the drawings.

1.3 REGULATORY REQUIREMENTS

A. Perform Work in accordance with all applicable state and local codes, standards and regulations.

B. Furnish all materials and labor which is required for compliance with codes, standards and regulations, whether specifically mentioned in these specifications or shown on the drawings.

C. Obtain the required construction permit from the authority having jurisdiction and arrange, at the proper time, for all inspections required by such authority. Pay all permit and inspection costs required.

1.4 COORDINATION OF WORK

A. The contractor is responsible for coordination of work between trades. Provide fully complete and functional systems.

B. Compare plumbing drawings and specifications with the drawings and specifications for other trades.

C. Coordinate plumbing installation with the work of other trades. Report any pertinent discrepancies to the Architect/Engineer and obtain written instructions for any necessary revisions. Before starting any construction, make proper provisions to avoid interferences in a manner approved by the Architect/Engineer. No extras will be allowed for rework of uncoordinated installations.

D. Determine the exact route and location of each plumbing item prior to fabrication and/or installation. Adjust location of piping and equipment, etc., to accommodate interferences anticipated and encountered.

E. Right of Way: General priority for right of way is as follows:

1. Items located per regulatory requirement.
2. Piping with pitch requirement (plumbing drains, etc.).
3. Ductwork.
4. Piping without pitch requirement.
5. Electrical wiring (conduits, etc.).

F. Arrange all work to permit removal (without damage to other parts) of any equipment requiring periodic replacement.

G. Provide clearance and easy access to any equipment which requires periodic maintenance. Arrange ducts, piping and equipment to permit ready access to valves, cocks, traps, starters, motors, control components, etc., and to clear the opening of swinging doors and access panels.

1.5 EQUIPMENT AND MATERIALS (GENERAL)

A. Provide all new materials unless specifically indicated otherwise.

B. Manufacturers and models listed in drawings and specifications are used for layout and to convey to bidders the general style, type, character and quality of product desired. Listed examples are used only to denote the quality standard of product desired and are not intended to restrict bidders to a specific brand, make, manufacturer or specific name.

C. Adjust layout, system connections and coordinate with other trades as required to properly install equivalent products.

D. Where equivalent products are submitted, include all associated costs related to substitution in bid.

E. Furnish materials bearing the manufacturer's name and trade name. Provide UL label where a UL standard has been established for the material.

F. Furnish standard products of manufacturers regularly engaged in production of equipment types required for the work. Use the manufacturer's latest approved design.

G. Use the same manufacturer for equipment and materials of the same general type throughout the work to obtain uniform appearance, operation and maintenance.

H. Protect equipment and materials from dirt, water, chemical or mechanical injury and theft always during construction. Provide covers or shelter as required.

I. If materials or equipment are damaged at any time prior to final acceptance of the work, repair such damage at no additional cost. If materials or equipment are damaged by water, provide replacement no additional cost.

J. Follow manufacturers' directions completely in the delivery, storage, protection and installation of all equipment and materials. Notify the Architect/Engineer in writing of any conflicts between any requirements of the contract documents and manufacturer's directions. Obtain written instructions before proceeding with the work. The Contractor is responsible for correction of any work that does not comply with the manufacturer's directions or written instructions from the Architect/Engineer at no additional cost.

K. Repair any damage to factory applied paint finish using touch-up paint furnished by the equipment manufacturer. Repaint the entire damaged panel or section per the field painting specifications in Division 09 at no additional cost.

1.6 OPERATION AND MAINTENANCE MANUALS

A. Refer to individual plumbing sections and Division 01.

1.7 SEISMIC REQUIREMENTS

A. No requirements. The project is Seismic Design Category B.

1.8 PAINTING

A. Refer to Division 09.

B. Protect fixtures, valves, trim, etc. from field painting operations. Do not install escutcheons and trim until painting is complete.

1.9 LOCATIONS AND MEASUREMENTS

A. Location of plumbing work is shown on the drawings as accurately as possible. Field verify all measurements to insure that the work suits the surrounding trim, finishes and/or construction. Provide adjustment as necessary.

B. Make minor relocations of work prior to installation as required or as directed by the Architect/Engineer at no additional cost.

1.10 SUPERVISION

A. The contractor must provide an authorized and competent representative to constantly supervise the work from the beginning to completion and final acceptance. Insofar as possible, keep the same foreman and workmen throughout the project duration.

B. Representatives of Architect/Engineer, Owner, and local inspection authorities will make inspections during the progress of the work. Contractor to accommodate such inspections and correct deficiencies noted.

1.11 QUALITY AND WORKMANSHIP

A. Contractor to employ skilled tradesmen, laborers and supervisors. Final product to be neat, well finished, and professional installation.

B. Remove and replace any work considered substandard quality in the judgment of the Architect/Engineer.

1.12 EXCAVATION, TRENCHING AND BACKFILLING

A. Provide all excavation, trenching and backfilling as required to complete the work under this Division.

B. Contractor is responsible for investigating conditions prior to excavating and to exercise care during the excavation to avoid any utilities or other objects which may or may not be shown on the drawings.

C. Excavate so as not to endanger or damage existing utilities and structures. If damage occurs, repair damage to the satisfaction of the Architect/Engineer at no additional cost.

D. Lay out location of all ditching at grade and obtain approval from the Architect/Engineer prior excavating.

E. Remove and dispose of all surplus earth from the site.

F. Provide suitable backfill materials as required.

G. Perform excavation, trenching and shoring in accordance with rules and regulations set forth in Article XXI, Bulletin 1 “Trenching” as published in a separate bulletin by the North Carolina Department of Labor, Division of Standards and Inspection Construction Bureau.

H. Bid excavation work as unclassified with no extra payment for removal of rock, unsuitable soils, etc.

1.13 CLOSING IN WORK

A. Do not cover up or enclose work until it has been inspected, tested and approved by authorities having jurisdiction over the work. Uncover any such work for inspection and/or test at no additional cost. Restore the work to its original condition after inspection and/or test at no additional cost.

1.14 CUTTING AND PATCHING

A. Perform all cutting and patching necessary to install work under this Division.

B. Perform cutting and patching in professional, workmanlike manner.

C. Arrange work to minimize cutting and patching.

D. Do not cut joists, beams, girders, columns or any other structural members without written permission from the Architect/Engineer.

E. Cut opening only large enough to allow easy installation of piping, wiring or ductwork.

F. Patching material to match material removed.

G. Restore the patched surface to its original appearance at completion of patching.

H. Where waterproofed surfaces are patched, maintain the integrity of waterproofing.

I. Remove rubble and excess patching materials from the premises.

1.15 INTERPRETATION OF DRAWINGS

A. Drawings and specifications under this Division are complementary to each other. Provide any work specified herein and/or indicated on the drawings.

B. Drawings are diagrammatic and indicate generally the location of fixtures, piping, devices, equipment, etc. Follow drawings as closely as possible but arrange work to suit the finished surroundings and/or trim.

C. The words “furnish”, “provide”, and/or “install” as used in these drawings and specifications are interpreted to include all material and labor necessary to complete the item, system, equipment, etc.

D. Any omissions from either drawings or specifications are unintentional. The contractor is responsible for notifying the Architect/Engineer of any pertinent omissions before submitting a bid. Complete working systems are required, whether every small item of material is shown and specified or not.

1.16 ACCESSIBILITY

A. Locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment includes, but not be limited to, valves, traps, cleanouts, motors, controllers and drain points. If required for accessibility, furnish access doors for this purpose. Minor deviations from drawings may be made to allow for better accessibility.

B. Coordinate exact locations and size of access panels for each concealed device requiring service.

C. Access panels: Steel construction with 16-gauge frames and 18-gauge panels, factory primed with rust inhibiting paint, finish paint by Contractor. Provide suitable UL listed doors where installed in rated construction.

D. Coordinate access panel locations with architectural construction.

E. Access panels are not required for access to work located above a lift-out “T” bar type ceiling.

1.17 ELECTRICAL WORK IN CONNECTION WITH PLUMBING WORK

A. Comply with Division 26.

1.18 PLUMBING WORK IN CONNECTION WITH OTHER CONTRACTS

A. Provide plumbing services as required for items furnished by other contractors or vendors as shown on the plumbing drawings. Include rough-ins and final connections to equipment. Locations of connections shown on the drawings are approximate and some adjustment of actual connection locations should be anticipated. Coordinate exact connection requirements. Make final connections only after approval of the other contractor or vendor, in the contractor's or vendor's presence.

1. Site Utilities- In general, work under this Division covers work to five feet outside buildings. Extend and connect work under this Division to site utilities as required.

2. Owner Furnished Equipment- Obtain exact plumbing requirements and rough-in locations for Owner furnished equipment. Provide complete plumbing installation for proper operation of equipment.
3. Kitchen Equipment- Obtaining exact plumbing requirements and rough-in locations for kitchen equipment. Provide complete plumbing installation for proper operation of equipment.

1.19 CONSTRUCTION IN EXISTING BUILDINGS

A. Note that work performed under this contract is to be accomplished in an existing building. See Section 220010, Section 220020 and Division 01 Specifications Sections for additional requirements.

B. Provide safety barriers, protective devices, screening, etc., as required to maintain the safety of visitors in or near the work area.

C. Maintain clean work area. At the end of each working period, remove all debris, boxes, waste, etc. from the premises and dispose of properly.

D. Coordinate installation of new mechanical work in the existing building. Arrange piping, ductwork and equipment to avoid interference with existing architectural, structural, plumbing, mechanical and electrical work.

E. The contractor is responsible for all damage to existing buildings, grounds, walkways, pavement, etc. occurring during the course of his work. Repair any such damage to finish equal to that prior to damage to the satisfaction of the Architect/Engineer.

1.20 ALTERNATE BIDS

A. Alternate Bids are described in relevant sections of the General and Supplemental General Conditions and Division 01 Specification Sections.

1.21 PROJECT RECORD DRAWINGS

A. Submit under provisions of relevant sections of the General and Supplemental General Conditions and Division 01 Specification Sections.

B. As the work progresses, legibly record all field changes on a set of project contract drawings, herein after called the “record drawings.”

C. Accurately show the installed condition of plumbing work on record drawings.

1.22 PHASING OF THE WORK

A. Schedule work in accordance with the relevant sections of the General and Supplemental General Conditions and Division 01 Specifications Sections.

1 1.23 PROJECT CLOSEOUT

2 A. Submit under provisions of relevant sections of the General and Supplemental General Conditions
3 and Division 01 Specifications Sections.

4 PART 2 - PRODUCTS (Not Applicable)

5 PART 3 - EXECUTION (Not Applicable)

6 END OF SECTION 220000

SECTION 220010 - EXISTING PLUMBING CONDITIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Procedures for plumbing work in existing building.

1.2 PROJECT CONDITIONS

A. Conform to the requirements of Division 01 for cutting and patching. Conform to the requirements of Division 2 and Section 220020 for demolition.

B. Conduct work to minimize interference with adjacent and occupied building areas.

C. Cease operations immediately if structure appears to be in danger and notify Architect/Engineer. Do not resume operations until directed.

PART 2 - GENERAL

2.1 PATCHING MATERIALS

A. As specified in individual Sections.

PART 3 - GENERAL

3.1 PREPARATION

A. Coordinate plumbing service interruptions with the Owner.

B. Provide temporary and/or permanent plumbing as shown and/or as required by conditions to maintain existing systems in service during construction. Use hot-tapping valves if required.

C. Existing Plumbing Systems: Maintain existing plumbing systems in service. Disable systems outside construction area only to make tie-ins or switchovers. Obtain permission from the Owner at least 24 hours before partially or completely disabling plumbing. Minimize duration. Make temporary connections as required to maintain service in areas adjacent to work area.

D. Drawings are based on casual field observation and existing record documents. Survey the affected areas before submitting a bid proposal. Report discrepancies to the Architect/Engineer before disturbing the existing installation.

E. Field-verify existing conditions as related to interconnection of New Work. Determine exact methods of interface to obtain proper operation.

F. Coordinate existing and New Work interface prior to beginning any work. Adjust work to suit existing conditions. Some deviations in plan layout vs. actual conditions should be expected.

G. Provide, erect, and maintain temporary dust screens, safeguards, barricades, signage and similar measures, for protection of the public, Owner, Contractor=s employees, and existing construction to remain. Provide protective barriers indicated in the contract drawings.

3.2 EXISTING CONDITIONS

A. Verify existing conditions in field and determine which affect plumbing work. Secure utilities as required to prevent spills, leakage, etc.

B. Protect existing work to remain. Do not cut or remove any structural members.

C. Rework existing services to remain which interfere with new work.

END OF SECTION 220010

SECTION 220020 - PLUMBING DEMOLITION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Selective plumbing demolition.

B. Conform to the requirements of Division 01 for cutting and patching.

C. Conform to the requirements of Division 02 for selective demolition

1.2 PROJECT CONDITIONS

A. Conduct demolition to minimize interference with adjacent and occupied building areas.

B. Cease operations immediately if structure appears to be in danger and notify Architect/Engineer. Do not resume operations until directed.

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.

B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.

C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.

E. Dismantle: To remove by disassembling or detaching an item from the surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

PART 2 - GENERAL

2.1 PATCHING MATERIALS

A. As specified in individual Sections.

PART 3 - GENERAL

3.1 PREPARATION

A. Demolition Drawings are based on casual field observation. No record documents are available. Survey the affected areas before submitting a bid proposal. Report discrepancies to the Architect/Engineer before disturbing the existing installation.

B. Provide, erect, and maintain temporary dust screens, safeguards, barricades, signage and similar measures, for protection of the public, Owner, Contractor's employees, and existing construction to remain. Provide protective barriers indicated in the contract drawings.

C. Protect existing materials and existing improvements which are not to be demolished.

D. Prevent movement of structure; provide temporary bracing and shoring required to ensure safety of existing structure.

3.2 DEMOLITION

A. Disconnect, remove, cap, and identify plumbing work as indicated. Secure utilities as required to prevent spills, leakage, etc.

B. 'Dead Ends' (a branch leading from a soil, waste or vent pipe; a building drain; or a building sewer and terminating at a developed length of 2 feet or more by means of a plug, cap or other closed fitting) shall be prohibited. Abandoned piping is not considered a dead end if a cleanout is installed instead of a cap.

C. Demolish in an orderly and careful manner. Protect existing work to remain. Do not cut or remove any structural members.

D. Terminate all demolition work in a neat, finished manner.

E. Conceal or enclose abandoned work within building construction except as specifically noted.

F. Remove demolished materials from site except where specifically noted otherwise. Do not burn or bury materials on site.

G. Remove materials as Work progresses. Upon completion of Work, leave areas in clean condition.

H. Coordinate cutting and patching requirements.

END OF SECTION 220020

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves without waterstop.
2. Sleeves with waterstop.
3. Stack-sleeve fittings.
4. Grout.
5. Silicone sealants.
6. Escutcheons.
7. Thermometers, bimetallic actuated, lead free.
8. Pressure gauges, dial type, lead free.
9. Gauge attachments, lead free.
10. Test plugs, lead free.

B. Related Requirements:

1. Section 331415 "Site Water Distribution Piping" for domestic water meters and combined domestic and fire-protection water-service meters outside the building.

1.2 DEFINITIONS

A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product, excluding motors which are included in Part 1 of the plumbing equipment Sections.

    a. Include construction details, material descriptions, and dimensions of individual components, and finishes.
    b. Include operating characteristics and furnished accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of [**expansion joint,**] [**and**] [**gauge**] to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Domestic water for plumbing piping intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.

C. Capability: Provide products and installations to accommodate maximum axial movement as scheduled or indicated on Drawings.

2.2 SLEEVES AND SLEEVE SEALS

A. Sleeves without Waterstop:

1. PVC Pipe Sleeves: ASTM D1785, Schedule 40. Use for non-fire rated assemblies.
2. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange. Use for fire-rated assemblies.

B. Sleeves with Waterstop:

1. Description: Manufactured PVC/HDPE, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.

C. Stack-Sleeve Fittings:

1. Description: Manufactured, Dura-coated or Duco-coated cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.

    a. Underdeck Clamp: Clamping ring with setscrews.

D. Grout:

1. Description: Nonshrinking, for interior and exterior sealing openings in non-fire-rated walls or floors.
2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
3. Design Mix: 5000 psi, 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

E. Silicone Sealants:

1. Silicone Sealant, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.

2. Silicone Foam Sealant: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

2.3 ESCUTCHEONS

A. Escutcheon Types:

1. One-Piece, Stainless-Steel Type: With polished stainless steel finish.

2.4 METERS AND GAUGES FOR PLUMBING PIPING

A. Thermometers, Bimetallic Actuated, Lead Free:

1. Source Limitations: Provide lead-free bimetallic-actuated thermometers from a single manufacturer.
2. Standard: ASME B40.200.
3. Case: sealed type(s); stainless steel with 3-inch nominal diameter.
4. Dial: Nonreflective aluminum with permanent scale markings and scales in deg F.
5. Connector Type(s): Union joint, adjustable angle; with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
6. Stem: 0.25 or 0.375 inch in diameter; stainless steel.
7. Window: Safety glass.
8. Ring: Stainless steel.
9. Element: Bimetal coil.
10. Pointer: Dark-colored metal.
11. Accuracy: Plus or minus 1.5 percent of span.

B. Thermowells, Lead Free:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: Lead-free copper.
4. Material for Use with Steel Piping: Type 316 stainless steel.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, or as required to match threaded opening in pipe.
7. Internal Threads: Size and thread type as required to match thermometer mounting threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length to extend to center of pipe.
10. Lagging Extension: Include on thermowells for insulated piping and tubing. Extension is to be of sufficient length to extend beyond finished insulation surface.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
12. Heat-Transfer Medium: Mixture of graphite and glycerin.

C. Pressure Gauges, Dial Type, Lead Free - Direct Mounted, Metal Case:

1. Source Limitations: Provide dial-type, lead-free, direct-mounted, metal-case pressure gauges from single manufacturer.
2. Standard: ASME B40.100.
3. Case: Sealed Solid-front, pressure-relief type(s); Type 316 stainless steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Lead-free Bourdon tube.
5. Pressure Connection: Lead-free brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.

7. Dial: Nonreflective aluminum with permanent scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Safety glass.
10. Ring: Stainless steel.
11. Accuracy: Grade B, plus or minus 2 percent of middle half of span.

D. Gauge Attachments, Lead Free:

1. Snubbers: ASME B40.100, lead-free brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device. Include extension for use on insulated piping.
2. Valves: Lead-free brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

E. Test Plugs, Lead Free:

1. Source Limitations: Provide lead-free test plugs from single manufacturer.
2. Description: Test-station fitting made for insertion into piping tee fitting.
3. Body: Lead-free brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
4. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
5. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
6. Core Inserts: EPDM self-sealing rubber.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES - GENERAL

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

    a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

3. Using grout or silicone sealant, seal the space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire resistance of floor/slab/wall.

C. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants that joint sealant manufacturer's literature indicates is appropriate for size, depth, and location of joint.

D. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 INSTALLATION OF SLEEVES WITH WATERSTOP

A. Install sleeve with waterstop as new walls and slabs are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange centered across width of concrete slab or wall.

C. Secure nailing flanges to wooden concrete forms.

D. Using grout or silicone sealant, seal space around outside of sleeves. Select to maintain fire resistance of floor/slab/wall.

3.3 INSTALLATION OF STACK-SLEEVE FITTINGS

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
4. Using silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.

B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.4 INSTALLATION OF ESCUTCHEONS

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

3.5 INSTALLATION OF METERS AND GAUGES

A. Install thermometer with thermowell at each required thermometer location.

B. Install thermowells in vertical position in piping tees.

C. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

D. Install thermowells with extension on insulated piping.

E. Fill thermowells with heat-transfer medium.

F. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

G. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at most readable position.

H. Install valve and snubber in piping for each pressure gauge for fluids.

I. Install test plugs in piping tees.

J. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.
2. Inlet and outlet of each domestic hot-water storage tank.
3. Outlet side of hot-water-balancing valve.
4. Each main hot-water-recirculating line return pipe.

K. Install pressure gauges in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each domestic water pump.

3.6 CONNECTIONS

A. Install meters and gauges adjacent to machines and equipment to allow space for service and maintenance of meters, gauges, machines, and equipment.

3.7 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gauges to proper angle for best visibility.

3.8 FIELD QUALITY CONTROL

A. Sleeves and Sleeve Seals:

1. Perform the following tests and inspections:

a. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
b. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

2. Prepare test and inspection reports.

B. Escutcheons:

1. Using new materials, replace broken and damaged escutcheons and floor plates.

3.9 SLEEVES APPLICATION

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above and below Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

2. Concrete Slabs-on-Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs above Grade:

a. Sleeves with waterstops or stack-sleeve fittings.

4. Interior Wall and Partitions:

a. Sleeves without waterstops.

3.10 ESCUTCHEONS APPLICATION

A. Escutcheons for New Piping and Relocated Existing Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
2. Piping:

a. One-piece, stainless steel with polished stainless-steel finish.

3. Bare Piping at Wall and Floor Penetrations in Finished Spaces:

a. One-piece, stainless steel with polished stainless-steel finish.

4. Bare Piping at Ceiling Penetrations in Finished Spaces:

a. One-piece, stainless steel with polished stainless-steel finish.

5. Bare Piping in Unfinished Service Spaces:

a. One-piece, stainless steel with polished stainless-steel finish.

6. Bare Piping in Equipment Rooms:

a. One-piece, stainless steel with polished stainless-steel finish.

B. Escutcheons for Existing Piping to Remain:

a. Two-piece, stainless steel with polished stainless-steel finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping and Relocated Existing Piping: One piece, floor plate.
2. Existing Piping: Split floor plate.

3.11 THERMOMETER, LEAD FREE, APPLICATION

A. Thermometer stems are to be of length to match thermowell insertion length.

3.12 THERMOMETER, LEAD FREE, SCALE-RANGE APPLICATION

A. Scale Range for Domestic Hot-Water Piping:

1. 30 to 240 deg F.

3.13 PRESSURE-GAUGE SCALE-RANGE APPLICATION

A. Scale Range for Water Service Piping:

1. 0 to 160 psi.

B. Scale Range for Domestic Water Piping:

1. 0 to 100 psi.

C. Insert additional paragraphs for pressure-gauge scale ranges and applications.

END OF SECTION 220500

SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ball valves.
2. Butterfly valves.
3. Check valves.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene-diene terpolymer.

C. FKM: Fluoroelastomer.

D. PTFE: Polytetrafluoroethylene.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

    a. Include material descriptions and dimensions of individual components.
    b. Include operating characteristics and furnished accessories.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooved ends, press ends, solder ends, and weld ends.
3. Set ball valves open to minimize exposure of functional surfaces.
4. Set butterfly valves closed or slightly open.
5. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems or other components as lifting or rigging points unless specifically indicated for this purpose in manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Standards:

1. Domestic-water piping valves intended to convey or dispense water for human consumption must comply with the U.S. Safe Drinking Water Act (SDWA), requirements of authorities having jurisdiction, and NSF 61/NSF 372; or to be certified in compliance with NSF 61/NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. ASME Compliance:

1. ASME B16.34 for flanged-end connections.
2. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream piping unless otherwise indicated.

F. Valve Bypass and Drain Connections: MSS SP-45.

G. Valve Actuator Type:

1. Gear Actuator: For quarter-turn ball valves NPS 4 and larger.
2. Hand Lever: For quarter-turn ball valves smaller than NPS 4.

H. Valves in Insulated Piping:

1. Provide 2-inch extended neck stems.
2. Provide extended operating handles with nonthermal-conductive covering material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Provide memory stops that are fully adjustable after insulation is applied.

2.3 BALL VALVES, LEAD FREE

A. Ball Valves - CPVC, Union Type:

1. Standard: MSS SP-122.
2. Pressure Rating and Temperature: 125 psig, 150 psig, or other pressure at 73 deg F or other temperature. See Part 3 ball valve schedule articles.
3. Body Material: CPVC.
4. Body Design: Union type.
5. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded. See Part 3 ball valve schedule articles.
6. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket, socket or threaded, threaded, or flanged. See Part 3 ball valve schedule articles.
7. Ball: CPVC, full port.
8. Seals: PTFE or EPDM-rubber O-rings.
9. Handle: Tee shaped.

2.4 BUTTERFLY VALVES, LEAD FREE

A. Butterfly Valves - CPVC:

1. Pressure Rating and Temperature: 125 psig, 150 psig, or other pressure at 73 deg F or other temperature. See Part 3 butterfly valve schedule articles.
2. Body Material: CPVC.
3. Body Design: Flangeless (wafer) type.
4. Seat: EPDM rubber.
5. Seals: PTFE or EPDM-rubber O-rings.
6. Disc: CPVC.
7. Stem: Stainless steel.
8. Handle: Lever.

2.5 CHECK VALVES, LEAD FREE

A. Check Valves, Lead Free - CPVC, Union-Type Ball Check:

1. Pressure Rating and Temperature: 125 psig, 150 psig, or other pressure at 73 deg F or other temperature. See Part 3 check valve schedule articles.
2. Body Material: CPVC.
3. Body Design: Union-type ball check.
4. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded. See Part 3 check valve schedule articles.
5. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket, socket or threaded, threaded, flanged. See Part 3 check valve schedule articles.
6. Ball: CPVC.
7. Seals: EPDM- or FKM-rubber O-rings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

D. Examine press fittings to verify they have been properly pressed.

E. Do not attempt to repair defective valves; replace with new valves. Remove defective valves from site.

3.2 INSTALLATION OF VALVES

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Provide support of piping adjacent to valves such that no force is imposed upon valves.

C. Locate valves for easy access and where not blocked by equipment, other piping, or building components.

D. For valves in horizontal piping, install valves with stem at or above center of pipe.

E. Install valves in position that does not project into aisles or block access to other equipment.

F. Install valves in position to allow full stem and actuator or manual operator movement.

G. Verify that joints of each valve have been properly installed and sealed to assure there is no leakage or damage.

H. Install check valves for proper direction of flow and as follows:

1. Check Valves, Swing Type: In horizontal position with hinge pin level.
2. Check Valves, Lift Type: With stem upright and plumb.

I. Valve Tags: Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

J. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's written recommended maximum.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

B. Select valves with the following end connections:

1. Wafer-Type Valves: Flanged connections.

3.5 DOMESTIC HOT- AND COLD-WATER BALL VALVE SCHEDULE

A. For CPVC Pipe:

1. CPVC Union-Type Ball Check Valve: NPS 4 and smaller 125 psig at 73 deg F.

a. End Connections for Valves NPS 2 (DN 50) and Smaller: Socket.
b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Socket or Flanged.

3.6 DOMESTIC HOT- AND COLD-WATER BUTTERFLY VALVE SCHEDULE

A. For CPVC Pipe: CPVC butterfly valve for NPS 2-1/2 and larger.

3.7 DOMESTIC HOT- AND COLD-WATER CHECK VALVE SCHEDULE

A. For CPVC Pipe:

1. NPS 2 (DN 50) and Smaller: Union ball valve.
2. NPS 4 (DN 100) and Smaller: Union ball valve.

END OF SECTION 220523

1

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe hangers and supports - metal.
2. Thermal hanger-shield inserts.
3. Fastener systems.
4. Equipment supports.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 220500 "Common Work Results for Plumbing" for pipe guides and anchors.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

PART 2 - PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS - METAL

A. Pipe Hangers and Supports - Stainless Steel:
1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.2 THERMAL HANGER-SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100 psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125 psig minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: ASTM C552, Type II cellular glass with 100 psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125 psig minimum compressive strength.

C. For Clevis Hangers: Insert and shield are to cover bottom 180 degrees of pipe.

D. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.3 FASTENER SYSTEMS

A. Fastener System - Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities required for supported loads and building materials where used.

B. Fastener System - Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities required for supported loads and building materials where used.

1. Indoor Applications: Stainless steel.
2. Outdoor Applications: Stainless steel.

2.4 MATERIALS

A. Stainless Steel: ASTM A240/A240M.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination is to include weight of supported components plus 200 lb.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

A. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

B. Install lateral bracing with pipe hangers and supports to prevent swaying.

C. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Coordinate location of concrete inserts before concrete is placed.

D. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

E. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

F. Insulated Piping:

1. Attach clamps and spacers to piping.

a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

a. Thermal-hanger shield inserts may be used as an option. Include stainless steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields are to span an arc of 180 degrees.

a. Thermal-hanger shield inserts may be used as an option. Include stainless steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches long and 0.048 inch thick.
b. NPS 4 (DN 100): 12 inches long and 0.06 inch thick.
c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches long and 0.06 inch thick.
d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches long and 0.075 inch thick.

5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

G. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

H. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.

I. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick after concrete is placed and cured. Use installers that are licensed by powder-actuated tool manufacturer.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners in accordance with manufacturer's written instructions.
3. Install lag screw wood fasteners in accordance with manufacturer's written instructions.
4. Install fasteners in accordance with manufacturer's written instructions.

J. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

3.3 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.4 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use stainless steel pipe hangers and stainless-steel attachments for all environmental applications.

D. Use padded hangers for piping that is subject to scratching.

E. Use thermal hanger-shield inserts for insulated piping and tubing.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.

H. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.

I. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 220529

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Valve tags.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

C. Valve-numbering scheme.

D. Valve Schedules: For each piping system. Include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.
2. Letter and Background Color: As indicated for specific application under Part 3.
3. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
6. Fasteners: Stainless steel rivets.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

2.2 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.

B. Letter and Background Color: As indicated for specific application under Part 3.

C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:

1. Pipe size.
2. Flow-Direction Arrows: Include flow-direction arrows on[**main**] distribution piping. Arrows may be either integral with label or applied separately.
3. Lettering Size: Size letters in accordance with ASME A13.1 for piping.

2.3 VALVE TAGS

A. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: stainless steel, 0.024-inch minimum thickness, with predrilled or stamped holes for attachment hardware.
2. Fasteners: stainless-steel wire.

B. Letter and Background Color: As indicated for specific application under Part 3.

C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Include valve-tag schedule in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION, GENERAL REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS

A. Permanently fasten labels on each item of plumbing equipment.

B. Sign and Label Colors.

1. White letters on an ANSI Z535.1 safety-green background.

C. Locate equipment labels where accessible and visible.

3.4 INSTALLATION OF PIPE LABELS

A. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

B. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Within 3 ft. of each valve and control device.
2. At access doors, manholes, and similar access points that permit view of concealed piping.
3. Within 3 ft. of equipment items and other points of origination and termination.
4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping and equipment.

C. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.

D. Flow-Direction Flow Arrows: Use arrows, in compliance with ASME A13.1, to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

E. Pipe-Label Color Schedule:

1. Domestic Cold-Water Piping: White letters on an ANSI Z535.1 safety-green background.
2. Domestic Hot-Water Piping: White letters on an ANSI Z535.1 safety-green background
3. Domestic Hot-Water Return Piping White letters on an ANSI Z535.1 safety-green background.
4. Sanitary Waste-Vent and Storm Drainage Piping: White letters on a black background.

3.5 INSTALLATION OF VALVE TAGS

A. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions like those indicated in "Valve-Tag Size and Shape" Subparagraph below:

1. Valve-Tag Size and Shape:

a. Domestic Cold Water: 1-1/2 inches, round.

b. Domestic Hot Water: 1-1/2 inches, round.
c. Domestic Hot-Water Return: 1-1/2 inches, round.

2. Valve-Tag Colors:

a. For each piping system, use the same lettering and background coloring system on valve tags as used in the piping system labels and background.

END OF SECTION 220553

SECTION 220593 - TESTING, ADJUSTING, AND BALANCING FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. TAB of domestic water system.
2. TAB of plumbing equipment:
    a. Domestic water booster pumps.
    b. Domestic hot-water in-line circulation pumps.
3. Pipe-leakage test verification.

1.2 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. TAB: Testing, adjusting, and balancing.

C. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

D. TDH: Total dynamic head.

1.3 PREINSTALLATION MEETINGS

A. TAB Conference: Conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.

1. Minimum Agenda Items:
    a. The Contract Documents examination report.
    b. The TAB plan.
    c. Needs for coordination and cooperation of trades and subcontractors.
    d. Proposed procedures for documentation and communication flow.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 90 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 90 days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.

C. Strategies and Procedures Plan: Within 90 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.

D. System Readiness Checklists: Within 90 days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.

E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

F. Certified TAB reports.

G. Sample report forms.

H. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.5 QUALITY ASSURANCE

A. TAB Specialists Qualifications, Certified by AABC:

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
2. TAB Technician: Employee of the TAB specialist and certified by AABC.

B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

C. ASHRAE 188 Compliance: Comply with balancing and report requirements, Section 8.3 "Balancing."

D. Code and Authorities Having Jurisdiction Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.6 FIELD CONDITIONS

A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, and balancing valves and fittings. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine approved submittals for plumbing systems and equipment.

D. Examine design data, including plumbing system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about plumbing system and equipment controls.

E. Examine equipment performance data, including pump curves.

1. Relate performance data to Project conditions and requirements, including pump system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate pump system-effect factors to reduce performance ratings of plumbing equipment when installed under conditions different from the conditions used to rate equipment performance. Compare results with the design data and installed conditions.

F. Examine system and equipment installations, and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.

H. Examine plumbing equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

I. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainers are installed and clean.

J. Examine system pumps to ensure absence of entrained air in the suction piping.

K. Examine operating safety interlocks and controls on plumbing equipment.

L. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of plumbing systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Domestic Water System:

a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed in accordance with applicable code and authority having jurisdiction.
b. Water heaters are installed and functioning.
c. Piping is complete and all points of outlet are installed.
d. Water treatment is complete.
e. Systems are flushed, filled, and air purged.
f. Strainers are clean.
g. Control valves are functioning in accordance with the sequence of operation.
h. Shutoff and balance valves are 100 percent open.
i. Booster- and hot-water circulating pumps are operational and proper rotation is verified.
j. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
k. Variable-frequency controllers' startup is complete and safeties are verified.
l. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system in accordance with the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.

B. Cut insulation, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.

1. Where holes for probes are required in piping or equipment, install pressure and temperature test plugs to seal systems.
2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 220716 "Plumbing Equipment Insulation" and Section 220719 "Plumbing Piping Insulation."

C. Mark equipment and balancing devices, including valve position indicators and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR PLUMBING EQUIPMENT

A. Test, adjust, and balance plumbing equipment indicated on Drawings, including, but not limited to, the following:

1. Domestic water booster pumps.
2. Domestic water in-line pumps.

3. Domestic water heaters.

3.5 PROCEDURES FOR DOMESTIC WATER SYSTEMS

A. Prepare test reports for pumps and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required equipment flow rates with system design flow rates.

B. Prepare schematic diagrams of systems' Record drawings piping layouts.

C. In addition to requirements in "Preparation" Article, prepare domestic water systems for testing and balancing as follows:

1. Check expansion tank for proper setting.
2. Check water heater for proper discharge temperature setting.
3. Check remotest point of outlet for adequate pressure.
4. Check flow-control valves for proper position.
5. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
6. Verify that motor controllers are equipped with properly sized thermal protection.
7. Check that air has been purged from the system.

D. Measure and record upstream and downstream pressure of each piece of equipment.

E. Measure and record upstream and downstream pressure of pressure-reducing valves.

F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.

G. Check settings and operation of each safety valve. Record settings.

3.6 PROCEDURES FOR DOMESTIC WATER SYSTEM BOOSTER PUMPS

A. Adjust pumps to deliver total design flow.

1. Measure total water flow.

    a. Position valves for full flow through coils.
    b. Measure flow by main flow meter, if installed.
    c. If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.

2. Measure pump TDH as follows:

    a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
    b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
    c. Convert pressure to head and correct for differences in gauge heights.
    d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.

3. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.

B. Adjust flow-measuring devices installed in mains and branches to design water flows.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

C. Verify final system conditions as follows:

1. Re-measure and confirm that total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
3. Mark final settings.

D. Verify that memory stops have been set.

3.7 PROCEDURES FOR DOMESTIC HOT-WATER CIRCULATING INLINE PUMP

A. Balance system with manual or automatic balancing valves by setting at design flow.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

B. Adjust pump to deliver total design flow.

1. Measure pump TDH as follows:

a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
c. Convert pressure to head and correct for differences in gauge heights.
d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.

2. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
3. Mark final settings and verify that all memory stops have been set.
4. Verify final system conditions as follows:

a. Re-measure and confirm that total flow is within design.
b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
c. Mark final settings.

3.8 PROCEDURES FOR MOTORS

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter size and thermal-protection-element rating.
8. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.9 PROCEDURES FOR WATER HEATERS

A. Electric Water Heaters:

1. Measure and record entering- and leaving-water temperatures.
2. Measure and record water flow.
3. Measure and record pressure drop.
4. Measure and Record relief valve(s) pressure setting.
5. Capacity: Calculate in Btu/h of heating output.
6. Efficiency: Calculate operating efficiency for comparison to submitted equipment.

3.10 TOLERANCES

A. Set plumbing system's flow rates within the following tolerances:

1. Domestic Water Flow Rate: Plus 10 percent or minus 5 percent. If design value is less than 10 gpm, within 10 percent.

3.11 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to plumbing systems and general construction to allow access for performance-measuring and -balancing devices.

3.12 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.

3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information related to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents, including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Notes to explain why certain final data in the body of reports vary from indicated values.
14. Test conditions for pump performance forms, including the following:

    a. Variable-frequency controller settings for variable-flow hydronic systems.
    b. Settings for pressure controller(s).
    c. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of distribution systems. Present each system with single-line diagram and include the following:

1. Flow rates.
2. Pipe and valve sizes and locations.
3. Balancing stations.
4. Position of balancing devices.

E. Electric Water Heater Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

    a. System identification.
    b. Location.
    c. Model number and unit size.
    d. Manufacturer's serial number.

e. Output capacity in Btu/h.
f. Number of stages.
g. Connected volts, phase, and hertz.
h. Rated amperage.

2. Test Data (Indicated and Actual Values):

a. Heat output in Btu/h.
b. Entering-water temperature in deg F.
c. Leaving-water temperature in deg F.
d. High-temperature-limit setting in deg F.
e. Operating set point in deg F.
f. Voltage at each connection.
g. Amperage for each phase.

F. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves, and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm.
g. Water-pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump speed.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

G. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.13 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Architect.

B. Architect shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.

E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.
2. If the second final inspection also fails, Owner may pursue other Contract options to complete TAB work.

F. Prepare test and inspection reports.

3.14 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

END OF SECTION 220593

SECTION 220719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following plumbing piping services:

1. Domestic cold-water piping.
2. Domestic hot-water piping.
3. Domestic recirculating hot-water piping.
4. Roof drains and rainwater leaders.
5. Supplies and drains for handicap-accessible lavatories and sinks.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.5 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.6 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. All Insulation Installed Indoors; Outdoors-Installed Insulation in Contact with Airstream: Flame-spread index of 25 or less, and smoke-developed index of 50 or less

2.2 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials are applied.

B. Products do not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric: Closed-cell or expanded-rubber materials; suitable for maximum use temperature between minus 70 deg F and 220 deg F. Comply with ASTM C534/C534M, Type I for tubular materials.

2.3 ADHESIVES

A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.

1. Flame-spread index is 25 or less and smoke-developed index is 50 or less as tested in accordance with ASTM E84.
2. Wet Flash Point: Below 0 deg F.
3. Service Temperature Range: 40 to 200 deg F.
4. Color: Black.

C. PVC Jacket Adhesive: Compatible with PVC jacket.

2.4 SEALANTS

A. Materials are as recommended by the insulation manufacturer and are compatible with insulation materials, jackets, and substrates.

B. Joint Sealants:

1. Permanently flexible, elastomeric sealant.
2. Service Temperature Range: Minus 58 to plus 176 deg F.
3. Color: White or gray.

C. PVC Jacket Flashing Sealants:

1. Fire- and water-resistant, flexible, elastomeric sealant.
2. Service Temperature Range: Minus 40 to plus 250 deg F.
3. Color: White.

2.5 FIELD-APPLIED JACKETS

A. Field-applied jackets comply with ASTM C1136, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.
2. Color: White.
3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

    a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

2.6 TAPES

A. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

2.7 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock positions) of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with Contract Documents.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 4 inches o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles below.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered or routed fittings made from same material and density as that of adjacent pipe insulation. Each piece is butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation conforms to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install sections of pipe insulation and miter if required in accordance with manufacturer's written instructions.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated valve covers manufactured of same material as that of pipe insulation when available.
2. When prefabricated valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF FIELD-APPLIED JACKETS

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.8 FINISHES

A. Flexible Elastomeric Thermal Insulation: After the adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.10 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. All Pipe Sizes: Insulation is the following:

    a. Flexible Elastomeric: 1 inch thick.

B. Domestic Hot and Recirculated Hot Water:

1. All Pipe Sizes: Insulation is the following:

    a. Flexible Elastomeric: 1 inch thick.

C. Stormwater and Overflow:

1. All Pipe Sizes: Insulation is the following:

    a. Flexible Elastomeric: 1 inch thick.

D. Roof Drain and Overflow Drain Bodies:

1. All Pipe Sizes: Insulation is the following:

a. Flexible Elastomeric: 1 inch thick.

E. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

1. All Pipe Sizes: Insulation is the following:

a. Flexible Elastomeric: 1/2 inch thick.

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.

D. Piping, Exposed:

1. PVC: 30 mils thick.

END OF SECTION 220719

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. CPVC piping - domestic water.

B. Related Requirements:

1. Section 331415 "Site Water Distribution Piping" for water-service piping and water meters outside the building from source to the point where water-service piping enters the building.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality-control reports.

1.4 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service in accordance with requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of water service.
2. Do not interrupt the water service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Domestic water piping, tubing, fittings, joints, and appurtenances intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PIPING MATERIALS

A. Potable-water piping and components are to comply with NSF 14, NSF 61, and NSF 372. Include marking "NSF-pw" on piping.

2.3 CPVC PIPING - DOMESTIC WATER

A. Source Limitations: Obtain CPVC piping from single manufacturer.

B. CPVC Pipe: ASTM F441/F441M, with wall thickness as indicated in "Piping Applications" Article.

1. CPVC Socket Fittings: ASTM F438 for Schedule 40.

2.4 PIPING JOINING MATERIALS - DOMESTIC WATER

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F493.

C. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.5 TRANSITION FITTINGS - DOMESTIC WATER

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Couplings - Domestic Water: AWWA C219.

1. Source Limitations: Obtain sleeve-type transition couplings from single manufacturer.

D. Plastic-to-Metal Transition Fittings - Domestic Water:

1. Source Limitations: Obtain plastic-to-metal transition fittings from single source.
2. Description:

a. CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
b. One end with threaded brass insert and one solvent-cement-socket end.

E. Plastic-to-Metal Transition Unions - Domestic Water:

1. Source Limitations: Obtain plastic-to-metal transition unions from single manufacturer.
2. Description:

a. CPVC four-part union.
b. Brass or stainless-steel threaded end.
c. Solvent-cement-joint plastic end.
d. Rubber O-ring.
e. Union nut.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 (DN 100 to DN 200) and larger is to be the following:

1. PVC, Schedule 40; socket fittings; and solvent-cemented joints.
2. Polypropylene (PP-R and PP-RCT), SDR 7.4 pipe and socket fusion, butt fusion, fusion outlet, or electrofusion fittings and joints.

D. Aboveground domestic water piping, NPS 2 (DN 50) and smaller is to be the following:

1. CPVC, Schedule 40; socket fittings; and solvent-cemented joints.

E. Aboveground domestic water piping, NPS 2-1/2 to NPS 5 (DN 65 to DN 125) is to be the following:

1. CPVC, Schedule 40; socket fittings; and solvent-cemented joints.

3.2 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.3 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install valves in accordance with Section 220523 "General-Duty Valves for Plumbing Piping."

C. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."

D. Install domestic water piping level without pitch and plumb.

E. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

F. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

G. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

H. Install piping to permit valve servicing.

I. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

J. Install piping free of sags and bends.

K. Install fittings for changes in direction and branch connections.

L. Install pressure gauges on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gauges in Section 220500 "Common Work Results for Plumbing."

M. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123.21 "Inline, Domestic Water Pumps."

N. Install thermometers on outlet piping from each water heater. Comply with requirements for thermometers in Section 220500 "Common Work Results for Plumbing."

O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."

P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.4 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
2. CPVC Piping: Join in accordance with ASTM D2846/D2846M.

D. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.5 INSTALLATION OF TRANSITION FITTINGS

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 (DN 50) and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings or unions.

3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for hangers, supports, and anchor devices in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Install vinyl-coated hangers for CPVC pipe, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Support horizontal piping within 12 inches of each fitting.

D. Support vertical runs of CPVC pipe to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.

3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.8 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system in accordance with either of the following:

        1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
        2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

    c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    d. Repeat procedures if biological examination shows contamination.
    e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.10 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

    a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
    b. Adjust calibrated balancing valves to indicated flows.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Piping Inspections:

a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after installation and before setting fixtures.
2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

a. Fill domestic water piping. Check components to determine that they are not air bound and that the piping is full of water.
b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 221116

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SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.
5. Temperature-actuated, water mixing valves.
6. Strainers for domestic water piping.
7. Outlet boxes.
8. Hose bibbs.
9. Wall hydrants.
10. Roof hydrants.
11. Drain valves.
12. Water-hammer arresters.
13. Trap-seal primer device.
14. Flexible connectors.

B. Related Requirements:

1. Section 220500 "Common Work Results for Plumbing."
2. Section 224500 "Emergency Plumbing Fixtures" for water tempering equipment.
3. Section 224700 "Drinking Fountains and Water Coolers."
4. Section 331415 "Site Water Distribution Piping" for fire water-service backflow prevention devices.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For domestic water piping specialties.

1.3 INFORMATIONAL SUBMITTALS

A. Test and inspection reports.

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or to be certified in compliance with NSF 61 and NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 VACUUM BREAKERS

A. Hose-Connection Vacuum Breakers:

1. Standard: ASSE 1011.
2. Body: Bronze, nonremovable, with manual drain.
3. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
4. Finish: Chrome or nickel plated.

2.4 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers: Refer to Plumbing Fixture Schedule on design drawings.

2.5 WATER PRESSURE-REDUCING VALVES

A. Water Regulators: Refer to Plumbing Fixture Schedule on design drawings.

2.6 BALANCING VALVES

A. Memory-Stop Balancing Valves:

1. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 2 or smaller.
4. Body: Copper alloy.
5. Port: Standard or full port.
6. Ball: Stainless steel.
7. Seats and Seals: Replaceable.
8. End Connections: Solder joint or threaded.
9. Handle: Vinyl-covered steel with memory-setting device.

2.7 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Individual-Fixture, Water Tempering Valves:

1. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
2. Pressure Rating: 125 psig minimum unless otherwise indicated.
3. Material: Bronze body with corrosion-resistant interior components.
4. Temperature Control: Adjustable.
5. Connections: Threaded inlets and outlet.
6. Finish: Chrome plated.
7. Tempered-Water Setting: Refer to Plumbing Fixture Schedule on design drawings.

2.8 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:
    a. Strainers NPS 2 (DN 50) and Smaller: 0.033 inch.
    b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.062 inch.
    c. Strainers NPS 5 (DN 125) and Larger: 0.125 inch.
6. Drain: Factory-installed, hose-end drain valve.

2.9 OUTLET BOXES

A. Clothes Washer Outlet Boxes: Refer to Plumbing Fixture Schedule on design drawings.

B. Icemaker Outlet Boxes: Refer to Plumbing Fixture Schedule on design drawings.

2.10 HOSE BIBBS

A. Hose Bibbs: Refer to Plumbing Fixture Schedule on design drawings.

2.11 WALL HYDRANTS

A. Nonfreeze Wall Hydrants: Refer to Plumbing Fixture Schedule on design drawings.

B. Nonfreeze Vacuum Breaker Wall Hydrants: Refer to Plumbing Fixture Schedule on design drawings.

2.12 ROOF HYDRANTS

A. Nonfreeze, Draining-Type Roof Hydrants: Refer to Plumbing Fixture Schedule on design drawings.

2.13 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.14 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Standard: ASSE 1010 or PDI-WH 201.
2. Type: Metal bellows.
3. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.15 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device:

1. Standard: ASSE 1018.
2. Pressure Rating: 125 psig minimum.
3. Body: Bronze.
4. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
5. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
6. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

2.16 FLEXIBLE CONNECTORS

A. Stainless Steel-Hose Flexible Connectors: Corrugated-stainless steel tubing with stainless steel wire-braid covering and ends welded to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig.
2. End Connections NPS 2 (DN 50) and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING SPECIALTIES

A. Backflow Preventers: Install in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in the same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
3. Do not install bypass piping around backflow preventers.

B. Water Regulators: Install with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gauges on inlet and outlet.

C. Balancing Valves: Install in locations where they can easily be adjusted. Set at indicated design flow rates.

D. Temperature-Actuated, Water Mixing Valves: Install with check stops or shutoff valves on inlets and with shutoff valve on outlet.

E. Y-Pattern Strainers: For water, install on supply side of each water pressure-reducing valve and pump.

F. Outlet Boxes: Install boxes recessed in wall or surface mounted on wall. Install 1-1/2-by-3-1/2-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."

G. Nonfreeze, Draining-Type Roof Hydrants: Install with drain connection piped to nearest floor drain or to the exterior.

H. Water-Hammer Arresters: Install in water piping in accordance with PDI-WH 201.

I. Supply-Type, Trap-Seal Primer Device: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

3.2 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

3.3 IDENTIFICATION

A. Plastic Labels for Equipment: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.
5. Temperature-actuated, water mixing valves.
6. Outlet boxes.
7. Wall hydrants.
8. Roof hydrants.
9. Trap-seal primer device.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

D. Adjust each reduced-pressure-principle backflow preventer in accordance with manufacturer's written instructions, authorities having jurisdiction and the device's reference standard.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.

1. Test each reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 221119

SECTION 221123.13 - DOMESTIC-WATER PACKAGED BOOSTER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Multiplex, variable-speed booster pumps.

B. Related Requirements:

1. Section 221123 "Domestic Water Pumps" for domestic-water circulation pumps.

1.2 DEFINITIONS

A. PID: Proportional Integral Derivative.

B. VFC: Variable-frequency controller.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and dimensions of individual components and profiles.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For booster pumps.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For booster pumps to include in emergency, operation, and maintenance manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Retain protective coatings and flange's protective covers during storage.

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

2.2 MULTIPLEX, VARIABLE-SPEED BOOSTER PUMPS

A. Description: Factory-assembled and -tested, fluid-handling system for domestic water, with pumps, piping, valves, specialties, and controls, and mounted on base.

B. Refer to Plumbing Fixture Schedule on design drawings for further information.

C. Pumps, Vertical, Multistage:

1. Type: Vertical, multistage as defined in HI 1.1-1.2 and HI 1.3 for in-line, multistage, separately coupled, overhung-impeller, centrifugal pump.
2. Casing: Cast-iron or steel base and stainless-steel chamber.
3. Impeller: Closed, stainless steel; statically and dynamically balanced and keyed to shaft.
4. Shaft: Stainless steel.
5. Seal: Mechanical.
6. Bearing: Water-lubricated sleeve type.

D. Motors: Single speed, with grease-lubricated, ball-bearings. Select motors that will not overload through full range of pump performance curve.

E. Piping: Stainless-steel pipe and fitting headers and copper tube and copper fittings between headers and pump.

F. Valves:

1. Shutoff Valves NPS 2 and Smaller: two-piece, full-port ball valve, in each pump's suction and discharge piping.
2. Check Valves NPS 2 and Smaller: Silent type in each pump's discharge piping.
3. Thermal-Relief Valve: Temperature-and-pressure relief type in pump's discharge header piping.

G. Dielectric Fittings: With insulating material to isolate joined dissimilar metals.

H. VFC Specified in Other Section: Comply with Section 262923 "Variable-Frequency Motor Controllers."

I. VFC: Serving each pump in pump array.

1. Manufactured Units: Pulse-width modulated; variable torque for inverter-duty motors.
2. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

3. Unit Operating Requirements:

a. Internal Adjustability:

1) Minimum Speed: 5 to 25 percent of maximum rpm.
2) Maximum Speed: 80 to 100 percent of maximum rpm.
3) Acceleration: 0.1 to 999.9 seconds.
4) Deceleration: 0.1 to 999.9 seconds.
5) Current Limit: 30 to minimum of 150 percent of maximum rating.

b. Self-Protection and Reliability Features:

1) Surge suppression.
2) Loss of input signal protection.
3) Under- and overvoltage trips.
4) VFC and motor overload/overtemperature protection.
5) Critical frequency rejection.
6) Loss-of-phase protection.
7) Reverse-phase protection.
8) Motor-overtemperature fault.

c. Bidirectional autospeed search.
d. Torque boost.
e. Motor temperature compensation at slow speeds.

1) Panel-mounted operator station.
2) Historical logging information and displays.
3) Digital indicating devices.

f. Control Signal Interface: Electric.
g. Proportional Integral Derivative (PID) control interface.
h. DDC System for HVAC Protocols for Network Communications: ASHRAE 135.

4. Line Conditioning:

a. Input line conditioning.
b. Output filtering.
c. EMI/RFI filtering.

5. Instrumentation: Suction and discharge pressure gauges.
6. Lights: Running light for each pump.
7. Alarm Signal Device: Sounds alarm when backup pumps are operating.

a. Time Delay: Controls alarm operation; adjustable from 1 to 300 seconds, with automatic reset.

8. Thermal-bleed cutoff.
9. Low-suction-pressure cutout.
10. High-suction-pressure cutout.
11. Low-discharge-pressure cutout.
12. High-discharge-pressure cutout.
13. Direct Digital Control (DDC) System for HVAC: Provide auxiliary contacts for interface to BACnet DDC system. DDC systems are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC." Include the following:

a. On-off status of each pump.
b. Alarm status.

J. Base: Structural steel.

K. Capacities and Characteristics:

1. Minimum Pressure Rating: 250 psig.
2. Booster-Pump Capacity: 400 gpm.
3. Minimum Inlet Pressure: 20 psig.
4. Maximum Inlet Pressure: 60 psig.
5. Discharge Pressure: 80 psig.
6. Lead Pump:

a. Capacity: 200 gpm.
b. Total Dynamic Head: 138 feet.
c. Speed: 3,500 rpm.
d. Electrical Characteristics:

1) Motor Horsepower: 15.
2) Volts: 480 V.
3) Phases: Three.
4) Hertz: 60 Hz.

7. Each of Two Lag Pumps:

a. Capacity: 200 gpm.
b. Total Dynamic Head: 138 feet.
c. Speed: 3,500 rpm.
d. Electrical Characteristics:

1) Motor Horsepower: 15.
2) Volts: 480 V.
3) Phases: Three.
4) Hertz: 60 Hz.

8. Booster-Pump Electrical Characteristics:

a. Full-Load Amperes: 63 A.
b. Minimum Circuit Ampacity: 68.2 A.
c. Maximum Overcurrent Protection: 90 A.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in NFPA 70.

2.4 SOURCE QUALITY CONTROL

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. ASME Compliance: Comply with ASME B31.9 for piping.

C. UL Compliance for Packaged Pumping Systems:

1. UL 508, "Industrial Control Equipment."
2. UL 508A, "Industrial Control Panels."
3. UL 778, "Motor-Operated Water Pumps."
4. UL 1995, "Heating and Cooling Equipment."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for booster pumps to verify actual locations of piping connections before booster-pump installation.

3.2 INSTALLATION

A. Booster-Pump Mounting:

B. Support connected domestic-water piping so weight of piping is not supported by booster pumps.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Booster-Pump Piping Connections: Connect domestic-water piping to booster pumps. Install suction and discharge pipe equal to or greater than size of system suction and discharge piping.

1. Install shutoff valves on piping connections to booster-pump suction and discharge piping. Install ball, butterfly, or gate valves same size as suction and discharge piping. Comply with requirements for general-duty valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."
2. Install union, flanged, or grooved-joint connections on suction and discharge piping at connection to domestic-water piping. Comply with requirements for unions and flanges specified in Section 221116 "Domestic Water Piping."
3. Install valved bypass, same size as and between piping, at connections to booster-pump suction and discharge piping. Comply with requirements for domestic-water piping specified in Section 221116 "Domestic Water Piping."
4. Install flexible connectors, same size as piping, on piping connections to booster-pump suction and discharge piping. Comply with requirements for flexible connectors specified in Section 221119 "Domestic Water Piping Specialties."
5. Where installing piping adjacent to booster pumps, allow space for service and maintenance.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.6 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.7 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

1. Perform visual and mechanical inspection.
2. Leak Test: After installation, charge booster pump and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start booster pumps to confirm proper motor rotation and booster-pump operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Pumps and controls will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.8 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.9 ADJUSTING

A. Adjust booster pumps to function smoothly and lubricate as recommended by manufacturer.

B. Adjust pressure set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting booster pump to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain booster pumps.

END OF SECTION 221123.13

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SECTION 221123.21 - INLINE, DOMESTIC-WATER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. In-line, sealless centrifugal pumps.

B. Related Requirements:

1. Section 221123.13 "Domestic-Water Packaged Booster Pumps" for booster systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction materials, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For inline, domestic-water pumps to include in operation and maintenance manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written instructions for handling.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: UL 778 for motor-operated water pumps.

C. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

2.2 IN-LINE, SEALLESS CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.

B. Capacities and Characteristics: Refer to Plumbing Fixture Schedule on design drawings.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220500 "Common Work Results for Plumbing."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.4 CONTROLS

A. DDC: Pump to be occupancy-scheduled control by DDC system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for domestic-water-piping system to verify actual locations of piping connections before pump installation.

3.2 INSTALLATION OF PUMPS

A. Comply with HI 1.4.

B. Mount pumps in orientation complying with manufacturer's written instructions.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to inline, domestic-water pumps, allow space for service and maintenance.

C. Connect domestic-water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between temperature controllers and devices.

3.5 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment" for identification of pumps.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Inline, domestic-water pump will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Perform the following startup checks for each pump before starting:

    a. Verify bearing lubrication.
    b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    c. Verify that pump is rotating in the correct direction.

5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.
8. Adjust temperature settings on thermostats.
9. Adjust timer settings.

3.8 ADJUSTING

A. Adjust inline, domestic-water pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature set points.

C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION 221123.21

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. PVC pipe and fittings.
2. Specialty pipe fittings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 FIELD CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service in accordance with requirements indicated:

1. Notify Architect, Construction Manager, and Owner no fewer than two days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with the interruption of sanitary waste service without Architect's, Construction Manager's, or Owner's written permission.

1.5 WARRANTY

A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation are capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10 ft. head of water.

2.2 PIPING MATERIALS

A. Piping materials to bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 PVC PIPE AND FITTINGS

A. Comply with NSF 14 for plastic piping components. Include "NSF-dwv" marking for plastic drain, waste, and vent piping and "NSF-sewer" marking for plastic sewer piping.

B. Solid-Wall PVC Pipe: ASTM D2665 drain, waste, and vent.

C. PVC Socket Fittings: ASTM D2665, made in accordance with ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

D. Adhesive Primer: ASTM F656.

E. Solvent Cement: ASTM D2564.

2.4 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections of same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Nonpressure Transition Couplings:

    a. Standard: ASTM C1173.
    b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
    c. End Connections: Same size as and compatible with pipes to be joined.
    d. Sleeve Materials:

        1) For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926 PVC.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
2. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install piping to allow application of insulation.

I. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.

1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
2. Use long-turn, double Y-branch, and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.

    a. Straight tees, elbows, and crosses may be used on vent lines.

3. Do not change direction of flow more than 90 degrees.
4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

    a. Reducing size of waste piping in direction of flow is prohibited.

J. Lay buried building waste piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

K. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Waste: Two percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Waste Piping: Two percent downward in direction of flow.
3. Vent Piping: One percent down toward vertical fixture vent or toward vent stack.

L. Install underground PVC piping in accordance with ASTM D2321.

M. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.

    a. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."

2. Install drains in sanitary waste gravity-flow piping.

    a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

N. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

O. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."

P. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.3 JOINT CONSTRUCTION

A. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Piping: Join in accordance with ASTM D2855 and ASTM D2665 appendixes.

3.4 INSTALLATION OF SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Waste Drainage Piping: Unshielded, nonpressure transition couplings.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment".

1. Install stainless steel pipe hangers for horizontal piping in corrosive environments.
2. Install stainless steel pipe support clamps for vertical piping in corrosive environments.
3. Vertical Piping: MSS Type 8 or Type 42 clamps.
4. Install individual, straight, horizontal piping runs:

    a. 100 Ft. (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Ft. (30 m): MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Ft. (30 m) if Indicated: MSS Type 49, spring cushion rolls.

5. Multiple, Straight, Horizontal Piping Runs 100 Ft. (30 m) or Longer: MSS Type 44 pipe rolls. Support pipe rolls on trapeze.
6. Base of Vertical Piping: MSS Type 52 spring hangers.

B. Install hangers for PVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

D. Support vertical runs of PVC piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Comply with requirements for cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."

6. Equipment: Connect waste piping as indicated.

a. Provide shutoff valve if indicated and union for each connection.
b. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections in accordance with the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary waste and vent piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.

a. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.

a. Close openings in piping system and fill with water to point of overflow, but not less than 10 ft. head of water.
b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
c. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.

a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
c. Air pressure must remain constant without introducing additional air throughout period of inspection.
d. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.9 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during the remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed Plastic Piping: Protect PVC plumbing vents exposed to sunlight with two coats of water-based latex paint.

E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.10 PIPING SCHEDULE

A. Aboveground, soil and waste piping NPS 4 (DN 100) and smaller are to be the following:

1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

B. Aboveground, soil and waste piping NPS 5 (DN 125) and larger are to be the following:

1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

C. Aboveground, vent piping NPS 4 (DN 100) is to be the following:

1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

D. Aboveground, vent piping NPS 5 (DN 125) and larger is to be the following:

E. Underground, soil, waste, and vent piping NPS 4 (DN 100) and smaller are to be the following:

1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

F. Underground, soil and waste piping NPS 5 (DN 125) and larger are to be the following:

1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

END OF SECTION 221316

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cleanouts.
2. Backwater Valves
3. Air-admittance valves.
4. Miscellaneous sanitary drainage piping specialties.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for through-penetration firestop assemblies.
2. Section 221423 "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.

1.2 DEFINITIONS

A. PVC: Polyvinyl chloride.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary waste piping specialty components.

2.2 BACKWATER VALVES

A. Horizontal, Plastic Backwater Valves:
   1. Size: Same as connected piping.
   2. Body: PVC.
   3. Cover: Same material as body with threaded access to check valve.
   4. Check Valve: Removable swing check.
   5. End Connections: Socket type.

2.3 CLEANOUTS

A. Plastic Floor Cleanouts:

   1. Size: Same as connected branch.
   2. Body: PVC.
   3. Closure Plug: PVC.
   4. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

2.4 AIR-ADMITTANCE VALVES

A. Fixture Air-Admittance Valves:

   1. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.
   2. Housing: Plastic.
   3. Operation: Mechanical sealing diaphragm.
   4. Size: Same as connected fixture or branch vent piping.

B. Wall Box for Air-Admittance Valves:

   1. Description: White plastic housing with white plastic grille, made for recessed installation. Include bottom pipe connection and space to contain one air-admittance valve.
   2. Size: Approximately 6 inches wide by 6 inches high by 4 inches deep.

2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

   1. Description: Shop or field fabricated from PVC soil-pipe fittings. Include P-trap, riser section; and where required, increaser fitting.
   2. Size: Same as connected waste piping with increaser fitting of size indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backwater valves in building drain piping.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install fixture air-admittance valves on fixture drain piping.

F. Install air-admittance-valve wall boxes recessed in wall.

G. Assemble open drain fittings and install with top of hub 2 inches above floor.

H. Install deep-seal traps on floor drains and other waste outlets, if indicated.

I. Install wood-blocking reinforcement for wall-mounting-type specialties.

J. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 PIPING CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment, to allow service and maintenance.

3.3 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

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SECTION 221319.13 - SANITARY DRAINS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Floor drains.
2. Floor sinks.
3. Trench drains.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 DRAIN ASSEMBLIES

A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.2 FLOOR DRAINS

A. Floor Drains: Refer to Plumbing Fixture Schedule on design drawings.

2.3 FLOOR SINKS

A. Floor Sinks: Refer to Plumbing Fixture Schedule on design drawings.

2.4 TRENCH DRAINS

A. Trench drains: Refer to Plumbing Fixture Schedule on design drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.

2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
3. Set with grates depressed according to the following drainage area radii:

    a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
    b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
    c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.

    a. Maintain the integrity of waterproof membranes where penetrated.

5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

B. Install trench drains at low points of surface areas to be drained.

1. Set grates of drains flush with finished surface, unless otherwise indicated.

C. Install open drain fittings with top of hub 2 inches above floor.

3.2 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements in Section 221319 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.

C. Install piping adjacent to equipment to allow service and maintenance.

3.3 LABELING AND IDENTIFYING

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 PROTECTION

A. Protect drains during the remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319.13

SECTION 221414 - STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. PVC pipe and fittings.

B. Related Requirements:

1. Section 334200 "Stormwater Conveyance" for storm drainage piping outside the building.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Reports: Inspection reports signed by authorities having jurisdiction.

1.4 QUALITY ASSURANCE

A. Provide materials bearing label, stamp, or other markings of specified testing agency.

1.5 FIELD CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Architect, Construction Manager, and Owner no fewer than two days in advance of proposed interruption of storm drainage service.
2. Do not proceed with interruption of storm drainage service without Architect’s, Construction Manager's, or Owner's written permission.

1.6 WARRANTY

A. Listed manufacturers to provide labeling and warranty of their respective products

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation are to be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Storm Drainage Piping: 10-foot head of water.

2.2 PIPING MATERIALS

A. Piping materials to bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 PVC PIPE AND FITTINGS

A. PVC Pipe:

1. Solid-Wall PVC Pipe: ASTM D2665 drain, waste, and vent.

B. PVC Socket Fittings:

1. Standard: ASTM D2665, made in accordance with ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Adhesive Primer: ASTM F656.

D. Solvent Cement: ASTM D2564.

2.4 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections of same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
3. Unshielded, Nonpressure Transition Couplings:

    a. Standard: ASTM C1173.
    b. Description: Elastomeric sleeve, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
    c. Sleeve Materials:

        1) For Cast-Iron Soil Pipes: ASTM C564 rubber.
        2) For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926 PVC.

3) For Dissimilar Pipes: ASTM D5926 PVC or other material compatible with pipe materials being joined.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

B. Install piping as indicated unless deviations from layout are approved on coordination drawings.

C. Install piping in concealed locations.

1. Piping installed in equipment rooms, service areas, and where indicated may be exposed.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Make changes in direction for piping using appropriate branches, bends, and long-sweep bends.

1. Do not change direction of flow more than 90 degrees.
2. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

    a. Reducing size of drainage piping in direction of flow is prohibited.

K. Lay buried building piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

L. Install piping at the following minimum slopes unless otherwise indicated.

1. Building Storm Drain: 1/4 inch per foot downward in direction of flow for piping NPS 3 and smaller; 1/8 inch per foot downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Storm Drainage Piping: 1/4 inch per foot downward in direction of flow.

M. Install aboveground PVC piping in accordance with ASTM D2665.

N. Install underground PVC piping in accordance with ASTM D2321.

O. Plumbing Specialties:

1. Install cleanouts in storm drainage gravity-flow piping in accessible locations.

   a. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
   b. Comply with requirements for cleanouts specified in Section 221423 "Storm Drainage Piping Specialties."

2. Install drains in storm drainage gravity-flow piping.

   a. Comply with requirements for drains specified in Section 221423 "Storm Drainage Piping Specialties."

P. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

Q. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."

R. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

S. Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.3 JOINT CONSTRUCTION

A. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Piping: Join in accordance with ASTM D2855 and ASTM D2665 appendices.

3.4 INSTALLATION OF SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Drainage Piping: Unshielded, nonpressure transition couplings.
3. In Aboveground Force-Main Piping: Fitting-type transition couplings.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for hangers, supports, and anchor devices specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install stainless-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless steel pipe hangers for horizontal piping in corrosive environments.
3. Install stainless steel pipe support clamps for vertical piping in corrosive environments.
4. Vertical Piping: MSS Type 8 or Type 42, clamps.
5. Install individual, straight, horizontal piping runs:

    a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.

6. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
7. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install hangers for PVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

D. Support vertical PVC piping with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

1. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
2. Comply with requirements for cleanouts and drains specified in Section 221423 "Storm Drainage Piping Specialties."

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.7 IDENTIFICATION

A. Identify exposed storm drainage piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

    a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

3. Test Procedure:

    a. Test storm drainage piping on completion of roughing-in.
    b. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
    c. From 15 minutes before inspection starts until completion of inspection, water level must not drop.
    d. Inspect joints for leaks.

4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.9 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

3.10 PROTECTION

A. Protect piping and drains during the remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day and when work stops.

C. Repair damage to adjacent materials caused by storm drainage piping installation.

3.11 PIPING SCHEDULE

A. Aboveground storm drainage piping NPS 6 and smaller is to be the following:

1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

B. Aboveground, storm drainage piping NPS 8 and larger is to be the following:

1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

C. Underground storm drainage piping NPS 6 and smaller shall be the following:

1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

D. Underground, storm drainage piping NPS 8 and larger is to be the following:

1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

END OF SECTION 221414

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SECTION 221423 - STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. General-purpose roof drains.
2. Cleanouts.

B. Related Requirements:

1. Section 076200 "Sheet Metal Flashing and Trim" for penetrations of roofs.
2. Section 078413 "Penetration Firestopping" for firestopping roof penetrations.

1.2 ACTION SUBMITTALS

A. Product Data:

1. General-purpose roof drains.
2. Cleanouts.

1.3 QUALITY ASSURANCE

A. Provide drainage piping specialties are to bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 GENERAL-PURPOSE ROOF DRAINS

A. Roof Drains:

1. General-Purpose Roof Drains: Refer to Plumbing Fixture Schedule on design drawings.
2. Piping Connection Type: Solvent welded.
3. Finish: Simulated oil-rubbed bronze.

2.2 CLEANOUTS

A. Plastic Cleanouts:

1. Plastic Cleanouts:

a. Size: Same as connected branch.
b. Body Material: PVC.
c. Closure Plug: PVC.

d. Type: Wall and floor.
e. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
f. Frame and Cover Shape: Round.
g. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install roof drains in accordance with roof membrane manufacturer's written installation instructions at low points of roof areas.

1. Install flashing collar or flange of roof drain to maintain integrity of waterproof membranes where penetrated.
2. Install expansion joints, if indicated, in roof drain outlets.
3. Position roof drains for easy access and maintenance.

B. Install cleanouts in aboveground piping and building drain piping in accordance with the following instructions unless otherwise indicated:

1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
3. Locate cleanouts at minimum intervals of 50 ft. for piping NPS 4 and smaller and 100 ft. for larger piping.
4. Locate cleanouts at base of each vertical storm piping conductor.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install test tees in vertical conductors and near floor.

F. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.

G. Install through-penetration firestop assemblies for penetrations of fire- and smoke-rated assemblies.

1. Comply with requirements in Section 078413 "Penetration Firestopping."

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 221414 "Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 INSTALLATION OF FLASHING

A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

3.4 CLEANING

A. Clean piping specialties during installation and remove dirt and debris as work progresses.

3.5 PROTECTION

A. Protect piping specialties during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of each day and when work stops.

END OF SECTION 221423

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SECTION 223300 - ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Commercial, electric, storage, domestic-water heaters.
2. Domestic-water heater accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Equipment room drawing or BIM model, drawn to scale, on which the items described in this Section are shown and coordinated with all building trades.

B. Product Certificates: For each type of commercial, electric, domestic-water heater.

C. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

D. Source quality-control reports.

E. Field quality-control reports.

F. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric, domestic-water heaters to include emergency, operation, and maintenance manuals.

1.5 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1 1.6 WARRANTY

2 A. Special Warranty: Manufacturer agrees to repair or replace components of electric, domestic-water
3 heaters that fail in materials or workmanship within specified warranty period.

4 1. Failures include, but are not limited to, the following:

5 a. Structural failures including storage tank and supports.
6 b. Faulty operation of controls.
7 c. Deterioration of metals, metal finishes, and other materials beyond normal use.

8 2. Warranty Periods: From date of Substantial Completion.

9 a. Commercial, Electric, Storage, Domestic-Water Heaters:

10 1) Storage Tank: Five years.
11 2) Controls and Other Components: Three years.

12 b. Expansion Tanks: Five years.

13 PART 2 - PRODUCTS

14 2.1 PERFORMANCE REQUIREMENTS

15 A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an
16 NRTL, and marked for intended location and use.

17 B. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial,
18 domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code:
19 Section VIII, Division 1.

20 C. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water
21 to comply with NSF 61 and NSF 372.

22 2.2 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

23 A. Commercial, Electric, Storage, Domestic-Water Heaters: Refer to Plumbing Fixture Schedule on
24 design drawings.

25 2.3 DOMESTIC-WATER HEATER ACCESSORIES

26 A. Domestic-Water Expansion Tanks: Refer to Plumbing Fixture Schedule on design drawings.

27 B. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of
28 domestic water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads.

29 C. Piping-Type Heat Traps: Field-fabricated piping arrangement in accordance with ASHRAE/IES 90.1.

30 D. Heat-Trap Fittings: ASHRAE/IES 90.1.

E. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valves with sensing element that extends into storage tank.

F. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.

2.4 SOURCE QUALITY CONTROL

A. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.

B. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in Section 033000 "Cast-in-Place Concrete."

1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.
3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
4. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
5. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
6. Install anchor bolts to elevations required for proper attachment to supported equipment.
7. Anchor domestic-water heaters to substrate.

B. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

C. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."

D. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220500 "Common Work Results for Plumbing."

E. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.

F. Fill electric, domestic-water heaters with water.

G. Charge domestic-water expansion tanks with air to required system pressure.

H. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water to contain less than 0.25 percent of lead by weight.

3.2 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial, electric, domestic-water heaters. Training to be a minimum of one hour(s).

END OF SECTION 223300

SECTION 224200 - COMMERCIAL PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Commercial lavatories.
2. Commercial showers.
3. Commercial sinks.
4. Commercial urinals.
5. Commercial water closets.
6. Flushometer valves.
7. Toilet seats.
8. Fixture carriers.

B. Related Requirements:

1. Section 224500 "Emergency Plumbing Fixtures" for emergency plumbing fixtures.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for plumbing fixtures.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. For lavatories and faucets.

    a. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

        1) Servicing and adjustments of automatic faucets.

2. For shower valves to include in maintenance manuals
3. For sinks and faucets to include in operation and maintenance manuals.

    a. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

        1) Servicing and adjustments of automatic faucets.

4. For flushometer valves and electronic sensors to include in operation and maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
2. Shower Valve Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
3. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than six of each type.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Lavatory faucets, sink faucets, shower valves, and wash fountain spray heads and faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 COMMERCIAL LAVATORIES

1. Lavatories, Counter Mounted: Refer to Plumbing Fixture Schedule on design drawings.

2. Lavatories, Undercounter Mounted: Refer to Plumbing Fixture Schedule on design drawings.

B. Lavatories, Wall Mounted: Refer to Plumbing Fixture Schedule on design drawings.

C. Lavatory Faucets, Manually Operated: Refer to Plumbing Fixture Schedule on design drawings.

D. Lavatory Faucets, Automatically Operated: Refer to Plumbing Fixture Schedule on design drawings.

E. Lavatory Supply Fittings:

1. NSF Standard: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.
2. Standard: ASME A112.18.1/CSA B125.1.
3. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless steel wall flange.

4. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
5. Operation: Loose key.
6. Risers:

    a. NPS 3/8.
    b. Chrome-plated, rigid-copper-pipe and brass straight or offset tailpieces riser.

F. Lavatory Waste Fittings:

1. Standard: ASME A112.18.2/CSA B125.2.
2. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.
3. Trap:

    a. Size: NPS 1-1/2 by NPS 1-1/4.
    b. Material:

        1) Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch-thick brass tube to wall; and chrome-plated, brass or steel wall flange.

2.3 COMMERCIAL SHOWERS

A. Showers, Individual and Shower Valve Assemblies: Refer to Plumbing Fixture Schedule on design drawings.

2.4 COMMERCIAL SINKS

A. Service Sinks, Floor Mounted: Refer to Plumbing Fixture Schedule on design drawings.

B. Kitchen/Utility Sinks: Refer to Plumbing Fixture Schedule on design drawings.

C. Sink Faucets: Refer to Plumbing Fixture Schedule on design drawings.

D. Sink Supply Fittings:

1. NSF Standard: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.
2. Standard: ASME A112.18.1/CSA B125.1.
3. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless steel wall flange.
4. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
5. Operation: Loose key.
6. Risers:

    a. NPS 3/8.
    b. Chrome-plated, rigid-copper pipe.

E. Sink Waste Fittings:

1. Standard: ASME A112.18.2/CSA B125.2.
2. Drain: Grid type with NPS 1-1/2 offset and straight tailpiece.
3. Trap:

a. Size: NPS 1-1/2.
b. Material:

1) Chrome-plated, two-piece, cast-brass trap and swivel elbow with 17-gauge brass tube to wall; and chrome-plated brass or steel wall flange.

F. Grout:

1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
2. Characteristics: Nonshrink; recommended for interior and exterior applications.
3. Design Mix: 5000 psi, 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

2.5 COMMERCIAL URINALS

A. Urinals, Wall Hung: Refer to Plumbing Fixture Schedule on design drawings.

2.6 COMMERCIAL WATER CLOSETS

A. Water Closets, Floor Mounted: Refer to Plumbing Fixture Schedule on design drawings.

B. Water Closets, Wall Mounted: Refer to Plumbing Fixture Schedule on design drawings.

2.7 FLUSHOMETER VALVES

A. Flushometer Valves, Manually Operated: Refer to Plumbing Fixture Schedule on design drawings.

B. Flushometer Valves, Sensor Operated: Refer to Plumbing Fixture Schedule on design drawings.

2.8 TOILET SEATS

A. Toilet Seats: Refer to Plumbing Fixture Schedule on design drawings.

2.9 FIXTURE CARRIERS

A. Fixture Carriers - Lavatory: Refer to Plumbing Fixture Schedule on design drawings.

1. Source Limitations: Obtain lavatory carriers from single source from single manufacturer.
2. Standards:

a. ASME A112.6.1M.
b. ASME A112.6.2.

B. Fixture Carriers - Urinal: Refer to Plumbing Fixture Schedule on design drawings.

1. Source Limitations: Obtain urinal carriers from single source from single manufacturer.
2. Standard: ASME A112.6.1M.

3. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings, gaskets, and feet; bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

C. Fixture Carriers - Water Closet: Refer to Plumbing Fixture Schedule on design drawings.

1. Source Limitations: Obtain water closet carriers from single source from single manufacturer.
2. Standard: ASME A112.6.1M.
3. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings, gaskets, and feet; bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water-supply piping and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine walls and floors for suitable conditions where plumbing fixtures will be installed.

C. Examine counters for suitable conditions where lavatories and sinks will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF COMMERCIAL PLUMBING FIXTURES

A. Lavatory Installation:

1. Install lavatories level and plumb in accordance with roughing-in drawings.
2. Install supports, affixed to building substrate, for wall-mounted lavatories.
3. Install accessible, wall-mounted lavatories at mounting height in accordance with ICC A117.1.
4. Install water-supply piping with stop on each supply to each lavatory faucet. Install stops in locations that are accessible for ease of operation.
5. Install trap and waste piping on each drain outlet of each lavatory to be connected to sanitary drainage system.
6. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220500 "Common Work Results for Plumbing."
7. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
8. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

B. Shower Installation:

1. Assemble shower components in accordance with manufacturers' written instructions.
2. Install ball valves in water-supply piping to the shower if supply stops are specified with the shower valve. Comply with ball valve requirements specified in Section 220523 "General Duty Valves for Plumbing Piping." Install valves in locations that are accessible for ease of operation.
3. Install shower flow-control fittings with specified maximum flow rates in shower arms.
4. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220500 "Common Work Results for Plumbing."
5. Seal joints between showers, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

C. Sink Installation:

1. Install sinks level and plumb in accordance with roughing-in drawings.
2. Set floor-mounted sinks in leveling bed of cement grout.
3. Install water-supply piping with stop on each supply to each sink faucet.

    a. Exception: Use ball or gate valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 220523 "General Duty Valves for Plumbing Piping."
    b. Install stops/valves in locations that are accessible for ease of operation.

4. Install trap and waste piping on each drain outlet of each sink to be connected to sanitary drainage system.
5. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220500 "Common Work Results for Plumbing."
6. Seal joints between sinks, counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
7. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

D. Urinal Installation:

1. Install urinals level and plumb in accordance with roughing-in drawings.
2. Install wall-hung, back-outlet urinals onto waste-fitting seals and attached to supports.
3. Install accessible, wall-mounted urinals at mounting height in accordance with ICC A117.1.
4. Install supports, affixed to building substrate, for wall-hung urinals.
5. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
6. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.
7. Measure support height installation from finished floor, not structural floor.
8. Install flushometer-valve, water-supply fitting on each supply to each urinal.
9. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
10. Install lever-handle flushometer valves for accessible urinals with handle mounted on open side of compartment.
11. Install actuators in locations easily reachable for people with disabilities.
12. Install new batteries in battery-powered, electronic-sensor mechanisms.
13. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Install deep-pattern escutcheons if required to conceal protruding fittings.

Comply with escutcheon requirements specified in Section 220500 "Common Work Results for Plumbing."

14. Seal joints between urinals, walls, and floors using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to urinal color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

E. Water Closet Installation:

1. Install water closets level and plumb in accordance with roughing-in drawings.
2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
3. Install accessible, wall-mounted water closets at mounting height in accordance with ICC A117.1.
4. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
5. Use carrier supports with waste-fitting assembly and seal.
6. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals, and affix to building substrate.
7. Measure support height installation from finished floor, not structural floor.
8. Install flushometer-valve, water-supply fitting on each supply to each water closet.
9. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
10. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
11. Install actuators in locations easily reachable for people with disabilities.
12. Install new batteries in battery-powered, electronic-sensor mechanisms.
13. Install toilet seats on water closets.
14. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Install deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220500 "Common Work Results for Plumbing."
15. Seal joints between water closets, walls, and floors using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to water-closet color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 INSTALLATION OF PIPING CONNECTIONS

A. Connect plumbing fixtures with water supplies and soil, waste, and vent piping. Use size fittings required to match plumbing fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil, waste, and vent piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

D. Install protective-shielding pipe covers and enclosures on exposed supplies and waste piping of accessible plumbing fixtures. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

E. Where installing piping adjacent to water closets and urinals, allow space for service and maintenance.

3.4 INSTALLATION OF ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.5 INSTALLATION OF CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 ADJUSTING

A. Operate and adjust plumbing fixtures and controls. Replace damaged and malfunctioning plumbing fixtures, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

C. Adjust water pressure at shower valves to produce proper flow.

D. Adjust water pressure at flushometer valves to produce proper flow.

E. Install new batteries in battery-powered, electronic-sensor mechanisms.

3.7 CLEANING AND PROTECTION

A. After completing installation of plumbing fixtures, inspect and repair damages finishes. Replace any fixtures unable to be repaired to the satisfaction of the Architect and Owner.

B. Clean plumbing fixtures and associated faucets, valves, flushometer valves, and fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed plumbing fixtures and associated faucets, valves, flushometer valves, and fittings.

D. Do not allow use of plumbing fixtures for temporary facilities unless approved by Owner.

END OF SECTION 224200

SECTION 224500 - EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Eye/face wash equipment.
2. Combination units.
3. Water-tempering equipment.

1.2 DEFINITIONS

A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

C. Tepid: Between 60 and 100 deg F.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Emergency fixture third-party certification documentation.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For emergency plumbing fixtures.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with ANSI/ISEA Z358.1 for emergency plumbing fixtures including third-party certification of fixtures.

B. Comply with ASSE 1071 for temperature-actuated mixing valves for plumbed emergency fixtures.

C. Comply with ASME A112.18.1/CSA B125.1 for water-supply fittings.

D. Comply with ASME A112.18.2/CSA B125.2 for plumbing waste fittings.

E. Comply with NSF 61 and NSF 372 for fixture materials that will be in contact with potable water.

F. Comply with requirements in ICC A117.1 for plumbing fixtures for people with disabilities.

2.2 EYE/FACE WASH EQUIPMENT

A. Eye/Face Wash Units - Plumbed: Refer to Plumbing Fixture Schedule on design drawings.

2.3 COMBINATION UNITS

A. Combination Units - Emergency Shower with Eyewash, Plumbed: Refer to Plumbing Fixture Schedule on design drawings.

2.4 WATER-TEMPERING EQUIPMENT

A. Water-Tempering Equipment - Hot and Cold Water:

1. Description: Factory-fabricated equipment with thermostatic mixing valve.

    a. Thermostatic Mixing Valve: Designed to provide 85 deg F tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
    b. Supply Connections: For hot and cold water.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF EMERGENCY PLUMBING FIXTURE

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.

B. Install fixtures level and plumb.

C. Fasten fixtures to substrate.

D. Install shutoff valves in water-supply piping to fixtures, to facilitate maintenance of equipment. Use ball or gate valve if specific type valve is not indicated. Install valves chained or locked in

open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."

1. Exceptions:

    a. Omit shutoff valve on supply to group of plumbing fixtures that includes emergency equipment.
    b. Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.

E. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 221116 "Domestic Water Piping."

F. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Section 220500 "Common Work Results for Plumbing."

G. Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."

H. Install indirect waste piping on drain outlet of emergency equipment receptors that are indicated to be indirectly connected to drainage system. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."

I. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

J. Fill self-contained fixtures with flushing fluid.

3.3 PIPING CONNECTIONS

A. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment. Comply with requirements for cold-water piping specified in Section 221116 "Domestic Water Piping."

B. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Section 221116 "Domestic Water Piping."

C. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."

D. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary waste or storm drainage piping.

E. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.4 IDENTIFICATION

A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.6 ADJUSTING

A. Operate and adjust emergency plumbing fixtures and controls. Replace damaged and malfunctioning fixtures and controls.

B. Adjust or replace fixture flow regulators for proper flow.

C. Adjust equipment temperature settings.

3.7 CLEANING AND PROTECTION

A. Clean emergency plumbing fixtures with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed emergency plumbing fixtures and fittings.

C. Do not allow use of emergency plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224500

SECTION 224700 - DRINKING FOUNTAINS AND WATER COOLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Water coolers.
2. Fixture carriers.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
b. Include operating characteristics, and furnished specialties and accessories.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For water coolers, bottle filling stations, to include in maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include servicing and adjustment of electronic-sensor fixtures.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filter Cartridges: Equal to 100 percent of quantity installed for each type and size indicated, but no fewer than five of each.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's written instructions for delivery, storage, and handling.

1.6 WARRANTY

A. Manufacturer Warranty: Manufacturer and Installer agree to repair or replace water coolers bottle filling stations that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Faulty operation of refrigeration system, leaks, valves, or electrical.
b. Deterioration of metals, metal finishes, and other materials beyond normal use.

B. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Standards:

1. Drinking fountains, water coolers, bottle filling stations, and remote water coolers intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), requirements of the authority having jurisdiction, and with NSF 61 or NSF 372, or be certified in compliance with NSF 61 or NSF 372 by an ANSI-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 WATER COOLERS

A. Water Coolers: Refer to Plumbing Fixture Schedule on design drawings.

2.3 FIXTURE CARRIERS

A. Fixture Carriers:

1. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

B. Examine walls and floors for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fixtures level and plumb in accordance with roughing-in drawings. For fixtures indicated for juveniles, install at height required by authorities having jurisdiction.

B. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.

C. Install mounting frames, affixed to building construction, and attach recessed water coolers and bottle filling stations to mounting frames.

D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220500 "Common Work Results for Plumbing."

G. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 PIPING CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Install ball shutoff valve on water supply to each fixture. Install valve upstream from filter for drinking fountain, water cooler, and bottle filling station. Comply with valve requirements specified in Section 220523 "General-Duty Valves for Plumbing Piping."

D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplates to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.5 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust water cooler temperature settings.

C. Adjust electronic-sensor settings.

3.6 CLEANING

A. After installing fixtures, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, in accordance with manufacturer's written instructions.

C. Provide protective covering for installed fixtures.

D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224700

SECTION 230000 – GENERAL MECHANICAL

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The work shall include furnishing, installing and testing the equipment and materials specified in other sections of the Mechanical Specifications and shown on the Drawings. It is the intent of these Specifications that the mechanical systems shall be suitable in every way for the intended usage. All material and all work which may be reasonably implied as being incidental to the work of this Division shall be furnished at no extra cost.

B. Instructions to Bidders, General Conditions of the Contract, Supplementary General Conditions and Division 1 Specifications Sections bound herewith are a component part of Division 23 specifications. Comply with all the provisions, details and instructions of these sections in the accomplishment of work covered under Division 23.

C. Furnish all labor, materials and equipment and incidentals required to make ready for use complete mechanical systems as shown on the Drawings and specified herein.

D. Where Sub-Contracts are used to perform portions of the work, division of labor between sub trades is the responsibility of the Contractor.

E. The general scope work includes, but is not limited to, furnishing, coordinating, and installing the following:

1. Heating, air conditioning and ventilation equipment.
2. Ductwork, air distribution.
3. HVAC piping, specialties and equipment.
4. Controls and wiring.
5. Commissioning, testing and balancing.

F. Visit all areas of the site, buildings and structures (as applicable) in which work under these sections is to be performed. Inspect carefully the existing conditions prior to bidding. Bid submission is evidence that the Contractor has examined the site and existing conditions, understands conditions under which the work will be performed, and takes full responsibility for complete knowledge of all factors governing the work.

G. Schedule all service interruptions in existing facilities at the Owner's convenience with 24 hours (minimum) notice. Obtain prior approval for each interruption.

H. Thoroughly test all mechanical systems at the completion of work and make any minor correction changes or adjustments necessary for all the proper functioning of the system and equipment. All workmanship shall be of the highest quality; substandard work will be rejected.

1.2 SUBMITTALS

A. Procedures for submittals: Submit under provisions of relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

Transmit each shop drawing submittal with provided Shop Drawing Submittal Cover Form, attached as Appendix B, for each item of equipment/material or each specification section/paragraph

B. Clearly indicate proposed equipment and/or materials substitutions in shop drawings. Summarize all deviations from the specified quality, functionality, appearance or performance of proposed equipment and/or materials in the preface of each submittal. Include documentation to support deviations.

C. Provide descriptive data on all materials and equipment as required to ascertain compliance with Specifications.

D. The design layout shown on drawings is based on physical sizes of reputable equipment manufacturers. If equipment other than the models indicated is installed, any resulting conflicts with space, maintenance access, clearances or codes are the responsibility of the Contractor to correct at his expense.

E. Where specific models and manufacturers of materials and equipment are specified, substitutions as allowed by the specifications and State law will be considered. Substitutions must be equivalent in quality, function, suitability and arrangement to specified equipment. Architect/Engineer to have final authority as to equivalency of substitutions.

F. Equipment model numbers noted in these specifications or on the drawings are intended to establish a minimum standard of quality and do not necessarily relate to specific options or arrangement as shown. Provide equipment with all standard features and optional features as stated and arranged as shown on the drawings.

1.3 REGULATORY REQUIREMENTS

A. Perform Work in accordance with all applicable state and local codes, standards and regulations.

B. Furnish all materials and labor which is required for compliance with codes, standards and regulations, whether specifically mentioned in these specifications or shown on the drawings.

C. Obtain the required construction permit from the authority having jurisdiction and arrange, at the proper time, for all inspections required by such authority. Pay all permit and inspection costs required.

1.4 COORDINATION OF WORK

A. The contractor is responsible for coordination of work between trades. Provide fully complete and functional systems.

B. Compare mechanical drawings and specifications with the drawings and specifications for other trades.

C. Coordinate mechanical installation with the work of other trades. Report any pertinent discrepancies to the Architect/Engineer and obtain written instructions for any necessary revisions. Before starting any construction, make proper provisions to avoid interferences in a manner approved by the Architect/Engineer. No extras will be allowed for rework of uncoordinated installations.

D. Determine the exact route and location of each mechanical item prior to fabrication and/or installation. Adjust location of ducts, piping and equipment, etc., to accommodate interferences anticipated and encountered.

E. Right of Way: General priority for right of way is as follows:

1. Items located per regulatory requirement.
2. Piping with pitch requirement (plumbing drains, etc.).
3. Ductwork.
4. Piping without pitch requirement.
5. Electrical wiring (conduits, etc.).

F. Arrange all work to permit removal (without damage to other parts) of any equipment requiring periodic replacement.

G. Provide clearance and easy access to any equipment which requires periodic maintenance. Arrange ducts, piping and equipment to permit ready access to valves, cocks, traps, starters, motors, control components, etc., and to clear the opening of swinging doors and access panels.

1.5 EQUIPMENT AND MATERIALS (GENERAL)

A. Provide all new materials unless specifically indicated otherwise.

B. Manufacturers and models listed in drawings and specifications are used for layout and to convey to bidders the general style, type, character and quality of product desired. Listed examples are used only to denote the quality standard of product desired and are not intended to restrict bidders to a specific brand, make, manufacturer or specific name.

C. Adjust layout, system connections and coordinate with other trades as required to properly install equivalent products.

D. Where equivalent products are submitted, include all associated costs related to substitution in bid.

E. Furnish materials bearing the manufacturer’s name and trade name. Provide UL label where a UL standard has been established for the particular material.

F. Furnish standard products of manufacturers regularly engaged in production of equipment types required for the work. Use the manufacturer's latest approved design.

G. Use the same manufacturer for equipment and materials of the same general type throughout the work to obtain uniform appearance, operation and maintenance.

H. Protect equipment and materials from dirt, water, chemical or mechanical injury and theft at all times during construction. Provide covers or shelter as required.

I. If materials or equipment are damaged at any time prior to final acceptance of the work, repair such damage at no additional cost. If materials or equipment are damaged by water, provide replacement no additional cost.

J. Follow manufacturers’ directions completely in the delivery, storage, protection and installation of all equipment and materials. Notify the Architect/Engineer in writing of any conflicts between any requirements of the contract documents and manufacturer’s directions. Obtain written

instructions before proceeding with the work. The Contractor is responsible for correction of any work that does not comply with the manufacturer's directions or written instructions from the Architect/Engineer at no additional cost.

K. Repair any damage to factory applied paint finish using touch-up paint furnished by the equipment manufacturer. Repaint entire damaged panel or section per the field painting specifications in Division 9 at no additional cost.

1.6 OPERATION AND MAINTENANCE MANUALS

A. Refer to individual mechanical sections and Division 1.

1.7 PAINTING

A. Protect sensors, controllers, etc. against painting. Do not install thermostats, devices or trim until painting is complete.

1.8 LOCATIONS AND MEASUREMENTS

A. Location of mechanical work is shown on the drawings as accurately as possible. Field verify all measurements to ensure that the work suits the surrounding structure, trim, finishes and/or construction. Provide adjustment as necessary.

B. Make minor relocations of work prior to installation as required or as directed by the Architect/Engineer at no additional cost.

1.9 SUPERVISION

A. Contractor must provide an authorized and competent representative to constantly supervise the work from the beginning to completion and final acceptance. Insofar as possible, keep the same foreman and workmen throughout the project duration.

B. Representatives of Architect/Engineer, Owner, and local inspection authorities will make inspections during the progress of the work. Contractor to accommodate such inspections and correct deficiencies noted.

1.10 QUALITY AND WORKMANSHIP

A. Contractor to employ skilled tradesmen, laborers and supervisors. Final product to present a neat, well finished, and professional installation.

B. Remove and replace any work considered substandard quality in the judgement of the Architect/Engineer.

1.11 EXCAVATION, TRENCHING AND BACKFILLING

A. Provide all excavation, trenching and backfilling as required to complete the work under this Division.

B. Contractor is responsible for investigating conditions prior to excavating and to exercise care during the excavation to avoid any utilities or other objects which may or may not be shown on the drawings.

C. Excavate so as not to endanger or damage existing utilities and structures. If damage occurs, repair damage to the satisfaction of the Architect/Engineer at no additional cost.

D. Lay out location of all ditching at grade and obtain approval from the Architect/Engineer prior excavating.

E. Remove and dispose of all surplus earth from the site.

F. Provide suitable backfill materials as required.

G. Perform excavation, trenching and shoring in accordance with rules and regulations set forth in Article XXI, Bulletin 1 “Trenching” as published in a separate bulletin by the North Carolina Department of Labor, Division of Standards and Inspection Construction Bureau.

H. Bid excavation work as unclassified with no extra payment for removal of rock, unsuitable soils, etc.

1.12 CLOSING IN WORK

A. Do not cover up or enclose work until it has been inspected, tested and approved by authorities having jurisdiction over the work. Uncover any such work for inspection and/or test at no additional cost. Restore the work to its original condition after inspection and/or test at no additional cost.

1.13 CUTTING AND PATCHING

A. Perform all cutting and patching necessary to install work under this Division.

B. Perform cutting and patching in professional, workmanlike manner.

C. Arrange work to minimize cutting and patching.

D. Do not cut joists, beams, girders, columns or any other structural members without written permission from the Architect/Engineer.

E. Cut opening only large enough to allow easy installation of piping, wiring or ductwork.

F. Patching material to match material removed.

G. Restore the patched surface to its original appearance at completion of patching.

H. Where waterproofed surfaces are patched, maintain the integrity of waterproofing.

I. Remove rubble and excess patching materials from the premises.

1.14 INTERPRETATION OF DRAWINGS

A. Drawings and specifications under this Division are complementary to each other. Provide any work specified herein and/or indicated on the drawings.

B. Drawings are diagrammatic and indicate generally the location of fixtures, piping, devices, equipment, etc. Follow drawings as closely as possible but arrange work to suit the finished surroundings and/or trim.

C. The words “furnish”, “provide”, and/or “install” as used in these drawings and specifications are interpreted to include all material and labor necessary to complete the particular item, system, equipment, etc.

D. Any omissions from either drawings or specifications are unintentional. The contractor is responsible for notifying the Architect/Engineer of any pertinent omissions before submitting a bid. Complete working systems are required, whether every small item of material is shown and specified or not.

1.15 ACCESSIBILITY

A. Locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment to include, but not be limited to, valves, traps, cleanouts, motors, controllers, and dampers. If required for accessibility, furnish access doors for this purpose. Minor deviations from drawings may be made to allow for better accessibility. Lack of access doors on drawings does not relieve Contractor of responsibility to provide access doors, if needed to properly service equipment.

B. Coordinate exact locations and size of access panels for each concealed device requiring service.

C. Access panels: Steel construction with 16-gauge frames and 18 gauge panels, factory primed with rust inhibiting paint, finish paint by Contractor. Provide suitable UL listed doors where installed in rated construction.

D. Coordinate access panel locations with architectural construction.

E. Access panels are not required for access to work located above a lift-out “T” bar type ceiling.

1.16 ELECTRICAL WORK IN CONNECTION WITH MECHANICAL CONTRACTS

A. Comply with Division 26. Any required Division 23 electrical work not specifically specified to be furnished by Division 26 Contractor shall be provided by Division 23 Contractor.

B. All electrical work performed in Division 23 shall comply with Division 26 specification requirements. Install control wiring in conduit.

C. Coordinate electrical interface of supplied mechanical equipment with electrical system. Division 26 electrical work for mechanical systems is based on values scheduled on mechanical drawings. Division 23 Contractor is responsible for any costs to modify the contracted electrical work to service equipment with electrical characteristics different than those scheduled.

1.17 MECHANICAL WORK IN CONNECTION WITH OTHER CONTRACTS

A. Provide mechanical services as required for items furnished by other contractors or vendors as shown on the Drawings. Actual requirements may vary from Drawings. Coordinate with equipment installed. Make final connections only after approval of the other contractor or vendor, in the contractor's or vendor's presence.

1.18 ALTERNATE BIDS

A. Alternate Bids, IF ANY, are described in relevant sections of the General and Supplemental General Conditions and Division 1 Specification Sections.

1.19 PROJECT RECORD DRAWINGS

A. Submit under provisions of relevant sections of the General and Supplemental General Conditions and Division 1 Specification Sections.

B. As the work progresses, legibly record all field changes on a set of project contract drawings, herein after called the "record drawings."

C. Record drawings shall accurately show the installed condition of mechanical work.

1.20 PHASING OF THE WORK

A. Schedule work in accordance with the relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

1.21 PROJECT CLOSEOUT

A. Submit under the provisions of relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 230000

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SECTION 230010 – EXISTING MECHANICAL CONDITIONS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Procedures for mechanical work in existing building.

1.2 RELATED WORK

A. Conform to the requirements of Division 1 for cutting and patching. Conform to the requirements of Division 2 and Section 23 00 20 for demolition.

B. Conduct work to minimize interference with adjacent and occupied building areas.

C. Cease operations immediately if structure appears to be in danger and notify Architect/Engineer. Do not resume operations until directed.

PART 2 - PRODUCTS

2.1 PATCHING MATERIALS

A. As specified in individual Sections.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate mechanical service interruptions with the Owner.

B. Provide temporary and/or permanent mechanical as shown and/or as required by conditions to maintain existing systems in service during construction. Use hot-tapping valves if required.

C. Existing Mechanical Systems: Maintain existing mechanical systems in service. Disable systems outside construction area only to make tie-ins or switchovers. Obtain permission from the Owner at least 24 hours before partially or completely disabling mechanical. Minimize duration. Make temporary connections as required to maintain service in areas adjacent to work area.

D. Drawings are based on casual field observation and existing record documents. Survey the affected areas before submitting bid proposal. Report discrepancies to the Architect/Engineer before disturbing the existing installation.

E. Field-verify existing conditions as related to interconnection of New Work. Determine exact methods of interface to obtain proper operation.

F. Coordinate existing and New Work interface prior to beginning any work. Adjust work to suit existing conditions. Some deviations in plan layout vs. actual conditions should be expected.

G. Provide, erect, and maintain temporary dust screens, safeguards, barricades, signage and similar measures, for protection of the public, Owner, Contractor's employees, and existing construction to remain. Provide protective barriers indicated in the contract drawings.

3.2 EXISTING CONDITIONS

A. Verify existing conditions in the field and determine which affect mechanical work. Secure utilities as required to prevent spills, leakage, etc.

B. Protect existing work to remain. Do not cut or remove any structural members.

C. Rework existing services to remain which interfere with new work.

END OF SECTION 230010

SECTION 230020 – MECHANICAL DEMOLITION

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Selective mechanical demolition.

B. Conform to the requirements of Division 01 for cutting and patching.

C. Conform to the requirements of Division 02 for selective demolition

1.2 PROJECT CONDITIONS

A. Conduct demolition to minimize interference with adjacent and occupied building areas.

B. Cease operations immediately if structure appears to be in danger and notify Architect/Engineer. Do not resume operations until directed.

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.

B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.

C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.

E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

PART 2 - PRODUCTS

2.1 PATCHING MATERIALS

A. As specified in individual Sections.

PART 3 - EXECUTION

3.1 PREPARATION

A. Demolition Drawings are based on casual field observation and existing record documents. Survey the affected areas before submitting bid proposal. Report discrepancies to the Architect/Engineer before disturbing the existing installation.

B. Provide, erect, and maintain temporary dust screens, safeguards, barricades, signage and similar measures, for protection of the public, Owner, Contractor's employees, and existing construction to remain. Provide protective barriers indicated in the contract drawings.

C. Protect existing materials and existing improvements which are not to be demolished.

D. Prevent movement of structure; provide temporary bracing and shoring required to ensure safety of existing structure.

3.2 DEMOLITION

A. Demolish mechanical work as indicated. Secure utilities as required to prevent spills, leakage, etc.

B. Demolish in an orderly and careful manner. Protect existing work to remain. Do not cut or remove any structural members.

C. Terminate all demolition work in a neat, finished manner.

D. Conceal or enclose abandoned work within building construction except as specifically noted.

E. Remove demolished materials from site except where specifically noted otherwise. Do not burn or bury materials on site.

F. Remove materials as Work progresses. Upon completion of Work, leave areas in clean condition.

G. Coordinate cutting and patching requirements.

END OF SECTION 230020

SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Motors.
2. Sleeves without waterstop.
3. Sleeves with waterstop.
4. Stack-sleeve fittings.
5. Sleeve-seal systems.
6. Grout.
7. Silicone sealants.
8. Escutcheons.
9. Thermometers, filled system.
10. Thermowells.
11. Pressure gauges, dial type.
12. Gauge attachments.
13. Test plugs.

1.2 DEFINITIONS

A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product, excluding motors which are included in Part 1 of HVAC equipment Sections.

    a. Include construction details, material descriptions, and dimensions of individual components, and finishes.
    b. Include operating characteristics and furnished accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of meter and gauge to include in operation and maintenance manuals.

1.6 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 MOTORS

A. Motor Requirements, General:

1. Content includes motors for use on alternating-current power systems of up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturers for field installation.
2. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.
3. Comply with NEMA MG 1 unless otherwise indicated.

B. Motor Characteristics:

1. Duty: Continuous duty at an ambient temperature of 40 deg C and at altitude of 3300 ft. above sea level.
2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

C. Polyphase Motors:

1. Description: NEMA MG 1, Design B, medium induction motor.
2. Efficiency: Premium Efficient, as defined in NEMA MG 1.
3. Service Factor: 1.15.
4. Multispeed Motors: Variable torque.
    a. For motors with 2:1 speed ratio, consequent pole, single winding.
    b. For motors with other than 2:1 speed ratio, separate winding for each speed.
5. Multispeed Motors, Two Winding: Separate winding for each speed.
6. Rotor: Random-wound, squirrel cage.
7. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
8. Temperature Rise: Match insulation rating.
9. Insulation: Class F.
10. Code Letter Designation:
    a. Motors 15 Hp and Larger: NEMA starting Code F or Code G.
    b. Motors Smaller Than 15 Hp: Manufacturer's standard starting characteristic.

11. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

D. Additional Requirements for Polyphase Motors:

1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
2. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

    a. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time-rise pulses produced by pulse-width-modulated inverters.
    b. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
    c. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
    d. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

E. Single-Phase Motors:

1. Motors larger than 1/20 hp must be one of the following, to suit starting torque and requirements of specific motor application:

    a. Permanent-split capacitor.
    b. Split phase.
    c. Capacitor start, inductor run.
    d. Capacitor start, capacitor run.

2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 hp and Smaller: Shaded-pole type.
5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device will automatically reset when motor temperature returns to normal range.

F. Electronically Commutated Motors:

1. Microprocessor-Based Electronic Control Module: Converts 120 V or 240 V single-phase AC power to three-phase DC power to operate the brushless DC motor.
2. Three-phase power motor module with permanent magnet rotor.
3. Digital speed controller/LED display.
4. Building Automation System Interface: Via DC voltage signal or Digital Serial Interface (DSI).

2.2 SLEEVES AND SLEEVE SEALS

A. Sleeves without Waterstop:

1. PVC Pipe Sleeves: ASTM D1785, Schedule 40.
2. Molded-PVC Sleeves: With nailing flange.

B. Sleeves with Waterstop:

1. Description: Manufactured PVC/HDPE, sleeve-type, waterstop assembly, made for imbedding in concrete slab or wall.

C. Stack-Sleeve Fittings:

1. Description: Manufactured, Dura-coated or Duco-coated cast-iron sleeve with integral cast flashing flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.

a. Underdeck Clamp: Clamping ring with setscrews.

D. Sleeve-Seal Systems:

1. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

a. Hydrostatic seal: 20 psig.
b. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
c. Pressure Plates: Stainless steel, Type 316.
d. Connecting Bolts and Nuts: Stainless steel, Type 316, of length required to secure pressure plates to sealing elements.

E. Grout:

1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
3. Design Mix: 5000 psi, 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

F. Silicone Sealants:

1. Silicone Sealant, S, P, T, NT: Single-component, 100/50, pourable, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant.

a. Standard: ASTM C920, Type S, Grade P, Class 100/50, Uses T and NT.

2.3 ESCUTCHEONS

A. Escutcheon Types:

1. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.

B. Floor Plates:

1. Split Floor Plates: Stainless-Steel with concealed hinge.

2.4 METERS AND GAUGES FOR HVAC PIPING

A. Thermometers, Filled System - Direct-Mounted, Metal-Case, Vapor-Actuated:

1. Source Limitations: Provide filled-system, direct-mounted, metal-case, vapor-actuated thermometers from a single manufacturer.
2. Standard: ASME B40.200.
3. Case: Sealed type, Stainless-Steel; 4-1/2-inch nominal diameter.
4. Element: Bourdon tube or other type of pressure element.
5. Movement: Mechanical, dampening type, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Stainless steel.
10. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device; with ASME B1.1 screw threads.
11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

12. Accuracy: Plus, or minus 1 percent of scale range.

B. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.
3. Type: Stepped shank unless straight or tapered shank is indicated.
4. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
5. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
6. Bore: Diameter required to match thermometer bulb or stem.
7. Insertion Length: Length required to match thermometer bulb or stem.
8. Lagging Extension: Include on thermowells for insulated piping and tubing.
9. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
10. Heat-Transfer Medium: Mixture of graphite and glycerin.

C. Pressure Gauges, Dial Type - Direct Mounted, Metal Case:

1. Source Limitations: Provide dial-type, direct-mounted, metal-case pressure gauges from single manufacturer.
2. Standard: ASME B40.100.
3. Case: Liquid-filled type(s); stainless steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanent scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Safety glass.
10. Ring: Stainless steel.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of span.

D. Gauge Attachments:

1. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device. Include extension for use on insulated piping.
2. Siphons: Loop-shaped section of stainless-steel pipe with NPS 1/4 or NPS 1/2 pipe threads.
3. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

E. Test Plugs:

1. Source Limitations: Provide test plugs from single manufacturer.
2. Description: Test-station fitting made for insertion in piping tee fitting.
3. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
4. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
5. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
6. Core Inserts: EPDM self-sealing rubber.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES - GENERAL

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 2-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

    a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

3. Using grout or silicone sealant, seal space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire resistance of floor/slab/wall.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Seal annular space between sleeve and piping or piping insulation; use joint sealants that joint sealant manufacturer's literature indicates is appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at

pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 INSTALLATION OF SLEEVES WITH WATERSTOP

A. Install sleeve with waterstop as new walls and slabs are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange centered across width of concrete slab or wall.

C. Secure nailing flanges to wooden concrete forms.

D. Using grout or silicone sealant, seal space around outside of sleeves.

3.3 INSTALLATION OF STACK-SLEEVE FITTINGS

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 3 inches above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.

B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.4 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.5 INSTALLATION OF ESCUTCHEONS

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

3.6 INSTALLATION OF METERS AND GAUGES

A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing, and support tubing to prevent kinks. Use minimum tubing length.

G. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.

H. Install valve and snubber in piping for each pressure gauge for fluids (except steam).

I. Install valve and syphon fitting in piping for each pressure gauge for steam.

J. Install test plugs in piping tees.

K. Install flow indicators in piping systems in accessible positions for easy viewing.

L. Install permanent indicators on walls or brackets in accessible and readable positions.

M. Install connection fittings in accessible locations for attachment to portable indicators.

N. Install thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler.
3. Two inlets and two outlets of each chiller.
4. Inlet and outlet of each hydronic coil in air-handling units.
5. Two inlets and two outlets of each hydronic heat exchanger.

O. Install pressure gauges in the following locations:

1. Discharge of each pressure-reducing valve.
2. Inlet and outlet of each chiller chilled-water and heating-water connection.
3. Suction and discharge of each pump.

3.7 CONNECTIONS

A. Install meters and gauges adjacent to machines and equipment to allow space for service and maintenance of meters, gauges, machines, and equipment.

3.8 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gauges to proper angle for best visibility.

3.9 FIELD QUALITY CONTROL

A. Sleeves and Sleeve Seals:

1. Perform the following tests and inspections:

a. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
b. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

2. Prepare test and inspection reports.

B. Escutcheons:

1. Using new materials, replace broken and damaged escutcheons and floor plates.

3.10 SLEEVES APPLICATION

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above and below Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

2. Concrete Slabs-on-Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs above Grade:

a. Sleeves with waterstops or stack-sleeve fittings.

4. Interior Walls and Partitions:

a. Sleeves without waterstops.

3.11 ESCUTCHEONS APPLICATION

A. Escutcheons for New Piping and Relocated Existing Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Insulated Piping:

    a. One-piece, stainless steel with polished stainless steel finish.

3. Bare Piping at Wall and Floor Penetrations in Finished Spaces:

    a. One-piece, stainless steel with polished stainless steel finish.

4. Bare Piping at Ceiling Penetrations in Finished Spaces:

    a. One-piece, stainless steel with polished stainless steel finish.

5. Bare Piping in Unfinished Service Spaces:

    a. One-piece, stainless steel with polished stainless steel finish.

6. Bare Piping in Equipment Rooms:

    a. One-piece, stainless steel with polished stainless steel finish.

B. Install floor plates for piping penetrations of equipment-room floors.

C. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping and Relocated Existing Piping: Split floor plate.
2. Existing Piping to Remain: Split floor plate.

3.12 THERMOMETER APPLICATION

A. Thermometers at inlet and outlet of each hydronic zone are to be the following:

1. Direct-mounted, metal-case, vapor-actuated type.
2. Test plug with EPDM self-sealing rubber inserts.

B. Thermometers at inlet and outlet of each hydronic boiler are to be the following:

1. Direct-mounted, metal-case, vapor-actuated type.
2. Test plug with EPDM self-sealing rubber inserts.

C. Thermometers at inlets and outlets of each chiller are to be the following:

1. Direct-mounted, metal-case, vapor-actuated type.
2. Test plug with EPDM self-sealing rubber inserts.

D. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems are to be the following:

1. Direct-mounted, metal-case, vapor-actuated type.
2. Test plug with EPDM self-sealing rubber inserts.

E. Thermometers at inlets and outlets of each hydronic heat exchanger are to be the following:

1. Direct-mounted, metal-case, vapor-actuated type.
2. Test plug with EPDM self-sealing rubber inserts.

F. Thermometer stems are to be of length to match thermowell insertion length.

3.13 THERMOMETER SCALE-RANGE APPLICATION

A. Scale Range for Chilled-Water Piping:

1. 0 to 250 deg F.

B. Scale Range for Heating, Hot-Water Piping:

1. 0 to 250 deg F.

3.14 PRESSURE-GAUGE APPLICATION

A. Pressure gauges at inlet and outlet of each chiller chilled-water and heating-water connection are to be the following:

1. Liquid filled, direct mounted, metal case.
2. Test plug with EPDM self-sealing rubber inserts.

B. Pressure gauges at suction and discharge of each pump are to be the following:

1. Liquid filled, direct mounted, metal case.
2. Test plug with EPDM self-sealing rubber inserts.

3.15 PRESSURE-GAUGE SCALE-RANGE APPLICATION

A. Scale Range for Chilled-Water Piping:

1. 0 to 200 psi.

B. Scale Range for Heating, Hot-Water Piping:

1. 0 to 200 psi.

END OF SECTION 230500

1 PART 4 -

SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ball valves.
2. Butterfly valves.
3. Check valves.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene-propylene-diene monomer.

C. PTFE: Polytetrafluoroethylene.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include material descriptions and dimensions of individual components.
2. Include operating characteristics and furnished accessories.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect flange faces and weld ends.
3. Set ball valves open to minimize exposure of functional surfaces.
4. Set butterfly valves closed or slightly open.
5. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems or other components as lifting or rigging points unless specifically indicated for this purpose in manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. ASME Compliance:

1. ASME B16.5 for flanges on valves.
2. ASME B16.5 for flanges on valves.
3. ASME B31.1 for power piping valves.
4. ASME B31.9 for building services piping valves.

B. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Bypass and Drain Connections: MSS SP-45.

E. Valve Actuator Type:

1. Gear Actuator: For quarter-turn ball valves NPS 4 and larger.
2. Hand Lever: For quarter-turn ball valves smaller than NPS 4.

F. Valves in Insulated Piping:

1. Provide 2-inch extended neck stems.
2. Provide extended operating handles with nonthermal-conductive covering material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Provide memory stops that are fully adjustable after insulation is applied.

2.3 BALL VALVES

A. Ball Valves - CPVC, Union Type:

1. Standard: MSS SP-122.
2. Pressure Rating and Temperature: 125 psig, 150 psig, or other pressure at 73 deg F or other temperature. See Part 3 ball valve schedule articles.
3. Body Material: CPVC.
4. Body Design: Union type.
5. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded. See Part 3 ball valve schedule articles.
6. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable socket, socket or threaded, threaded, or flanged. See Part 3 ball valve schedule articles.
7. Ball: CPVC; full port.
8. Seals: PTFE or EPDM-rubber O-rings.
9. Handle: Tee shaped.

B. Ball Valves - CPVC, Non-Union Type:

1. Standard: MSS SP-122.
2. Pressure Rating and Temperature: 125 psig, 150 psig, or other pressure at 73 deg F or other temperature. See Part 3 ball valve schedule articles.
3. Body Material: CPVC.
4. Body Design: Non-union type.
5. End Connections: Socket or threaded.
6. Ball: CPVC; full or reduced port.
7. Seals: PTFE or EPDM-rubber O-rings.
8. Handle: Tee shaped.

2.4 BUTTERFLY VALVES

A. Butterfly Valves, Single Flange (Lug Type) - CPVC, with Stainless-Steel Disc:

1. CWP Rating: 150 psig. See Part 3 butterfly valve schedule articles.
2. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
3. Body Material: CPVC Type IV Cell Classification 23447.
4. Seat: EPDM. See Part 3 butterfly valve schedule articles.
5. Stem: One- or two-piece stainless steel.
6. Disc: Stainless steel.

B. Butterfly Valves, Flangeless (Wafer Type) - CPVC, with Stainless Steel Disc:

1. CWP Rating: 150 psig. See Part 3 butterfly valve schedule articles.
2. Body Design: Flangeless (wafer type), suitable for bidirectional dead-end service at rated pressure.
3. Body Material: CPVC Type IV Cell Classification 23447.
4. Seat: EPDM. See Part 3 butterfly valve schedule articles.
5. Stem: One- or two-piece stainless steel.
6. Disc: Stainless steel.

2.5 CHECK VALVES

A. Check Valves - CPVC, Union-Type Ball Check:

1. Pressure Rating and Temperature: 125 psig, 150 psig, or other pressure at 73 deg F or other temperature. See Part 3 check valve schedule articles.
2. Body Material: CPVC.
3. Body Design: Union-type ball check.
4. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded. See Part 3 check valve schedule articles.
5. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket, socket or threaded, threaded, flanged. See Part 3 check valve schedule articles.
6. Ball: CPVC.
7. Seals: EPDM-rubber O-rings.

B. Check Valves - PVC, Union-Type Ball Check:

1. Pressure Rating and Temperature: 125 psig 150 psig, or other pressure at 73 deg F or other temperature. See Part 3 check valve schedule articles.
2. Body Material: PVC.
3. Body Design: Union-type ball check.

4. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded. See Part 3 check valve schedule articles.
5. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket, socket or threaded, threaded, flanged. See Part 3 check valve schedule articles.
6. Ball: PVC.
7. Seals: EPDM-rubber O-rings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Examine press fittings to verify they have been properly pressed.

F. Do not attempt to repair defective valves; replace with new valves. Remove defective valves from site.

3.2 INSTALLATION OF VALVES

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Provide support of piping adjacent to valves such that no force is imposed upon valves.

C. Locate valves for easy access and where not blocked by equipment, other piping, or building components.

D. For valves in horizontal piping, install valves with stem at or above center of pipe.

E. Install valves in position that does not project into aisles or block access to other equipment.

F. Install valves in position to allow full stem and actuator or manual operator movement.

G. Verify that joints of each valve have been properly installed and sealed to ensure that there is no leakage or damage.

H. Install check valves for proper direction of flow.

I. Valve Tags: Comply with requirements for valve tags and schedules in Section 230553 "Identification for HVAC Piping and Equipment."

J. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve of manufacturer's written recommended maximum.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.

B. Select valves with the following end connections:

1. Wafer-Type Valves: Flanged connections.

3.5 CHILLED-WATER BALL VALVE SCHEDULE

A. Pipe NPS 4 and Smaller:

1. Ball valves, CPVC, Union-Type.

3.6 COOLING-COIL CONDENSATE BALL VALVE SCHEDULE

A. For CPVC Pipe:

1. CPVC Union-Type Ball Valve: NPS 4 and smaller 150 psig at 73 deg F.

    a. End Connections for Valves NPS 2 (DN 50) and Smaller: Socket.
    b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Socket.

B. For PVC Pipe:

3.7 HEATING-WATER BALL VALVE SCHEDULE

A. Pipe NPS 4 and Smaller:

1. Ball valves, CPVC, Union-Type.

3.8 CHILLED-WATER BUTTERFLY VALVE SCHEDULE

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, single flange (lug type) - CPVC, with stainless steel disc; 150 CWP, EPDM seat.
2. Butterfly valves, flangeless (wafer type) - CPVC, with stainless steel disc; 150 CWP, EPDM seat.

3.9 HEATING-WATER BUTTERFLY VALVE SCHEDULE

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, single flange (lug type) - CPVC, with stainless steel disc; 150 CWP, EPDM seat.
2. Butterfly valves, flangeless (wafer type) - CPVC, with stainless steel disc; 150 CWP, EPDM seat.

3.10 CHILLED-WATER CHECK VALVE SCHEDULE

A. For CPVC Pipe:

1. CPVC Union-Type Ball Check Valve: NPS 4 and smaller 150 psig at 73 deg F.

    a. End Connections for Valves NPS 2 (DN 50) and Smaller: Socket.
    b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100) and Larger: Socket.

3.11 HEATING-WATER CHECK VALVE SCHEDULE

A. For CPVC Pipe:

1. CPVC Union-Type Ball Check Valve: NPS 4 and smaller 150 psig at 73 deg F.

    a. End Connections for Valves NPS 2 (DN 50) and Smaller: Socket.
    b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100) and Larger: Socket.

3.12 PUMP-DISCHARGE CHECK VALVE SCHEDULE

A. Chilled-Water Pump Discharge:

1. Check valves, wafer type, flanged ends - CPVC, with lever- and spring-closure control, Class 150.

B. Heating-Water Pump Discharge:

1. Check valves, wafer type, flanged ends - CPVC, with lever- and spring-closure control, Class 150.

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe hangers and supports - metal.
2. Pipe hangers - metal, trapeze type.
3. Pipe hangers - FRP.
4. Thermal-hanger shield inserts.
5. Fastener systems.

B. Related Requirements:

1. Section 230548.13 "Vibration Controls for HVAC" for vibration isolation devices.
2. Section 233113 "Metal Ducts" for duct hangers and supports.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers.
2. Pipe stands.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for HVAC piping and equipment are to withstand the effects of gravity loads and stresses within limits and under conditions indicated in accordance with ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.2 PIPE HANGERS AND SUPPORTS - METAL

A. Pipe Hangers and Supports - Stainless Steel:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.3 PIPE HANGERS - METAL, TRAPEZE TYPE

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural stainless-steel shapes with MSS SP-58 stainless-steel hanger rods, nuts, saddles, and U-bolts.

2.4 PIPE HANGERS - FRP

A. Pipe Hangers - FRP, Clevis Type:

1. Description: Similar to MSS SP-58, Type 1, factory-fabricated steel pipe hanger except hanger is made of fiberglass-reinforced plastic resin.
2. Hanger Rods: Continuous-thread stainless steel rod, washer, and nuts made of stainless steel.
3. Flammability: ASTM D635, ASTM E84, and UL 94.

2.5 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100 psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125 psi minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: ASTM C552, Type II cellular glass with 100 psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125 psi minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield are to cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield are to cover bottom 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond stainless-steel shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

A. Fastener System - Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities required for supported loads and building materials where used.

B. Fastener System - Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities required for supported loads and building materials where used.

1. Indoor Applications: Stainless steel.
2. Outdoor Applications: Stainless steel.

2.7 MATERIALS

A. Aluminum: ASTM B221.

B. Stainless Steel: ASTM A240/A240M.

C. Threaded Rods: Continuously threaded. Stainless steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.

D. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000 psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry static loads within specified loading limits. Minimum static design load used for strength determination is to include weight of supported components plus 200 lb.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

A. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

B. Install lateral bracing with pipe hangers and supports to prevent swaying.

C. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Coordinate location of concrete inserts before concrete is placed.

D. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

E. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

F. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Thermal-hanger shield inserts may be used as an option. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields are to span an arc of 180 degrees.

    a. Thermal-hanger shield inserts may be used as an option. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches long and 0.048 inch thick.
    b. NPS 4 (DN 100): 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches long and 0.06 inch thick.
    d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches long and 0.075 inch thick.

5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

G. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

H. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate in accordance with ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel in accordance with AWS D1.1/D1.1M.

I. FRP Pipe-Hanger Installation: Comply with applicable portions of MSS SP-58. Install hangers and attachments as required to properly support piping from building structure.

J. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

K. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick after concrete is placed and cured. Use installers that are licensed by powder-actuated tool manufacturer.
2. Install mechanical-expansion anchors after concrete is placed and completely cured.
3. Install fasteners in accordance with manufacturer's written instructions.
4. Install lag screw wood fasteners in accordance with manufacturer's written instructions.

L. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

M. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

N. Equipment Support Installation:

1. Fabricate from welded-structural-steel shapes.
2. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
3. Grouting: Place grout under supports for floor-mounted equipment, and make bearing surface smooth.
4. Provide lateral bracing, to prevent swaying.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to [**1-1/2 inches**] <**Insert dimension**>.

3.5 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in

D. Use stainless steel pipe hangers or FRP pipe hangers and stainless-steel attachments for all environment applications.

E. Use padded hangers for piping that is subject to scratching.

F. Use thermal-hanger shield inserts for insulated piping and tubing.

G. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230533 - HEAT TRACING FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes heat tracing for freeze prevention of HVAC piping with self-regulating, parallel-resistance, electric heating cables:

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

B. Shop Drawings: For electric heating cable.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric heating cables and controls to include in operation and maintenance manuals.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Source Limitations: Obtain all heat tracing from one manufacturer.

B. Standard: IEEE 515.1.

C. Heating Element: Pair of parallel No. 16 AWG, nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length.

D. Electrical Insulating Jacket: Flame-retardant polyolefin.

E. Grounding Cover: Tinned-copper braid.

F. Cable Cover: Stainless steel braid and polyolefin outer jacket with ultraviolet inhibitor.

G. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable is to be capable of crossing over itself once without overheating.

H. Maximum Operating Temperature (Power On): 150 deg F.

I. Maximum Exposure Temperature (Power Off): 185 deg F.

J. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

K. Capacities and Characteristics:

1. Maximum Heat Output: 5 W/ft.
2. Number of Parallel Cables: 1.
3. Electrical Characteristics for Single-Circuit Connection:

    a. Volts: 120 V.
    b. Phase: 1.
    c. Hertz: 60 Hz Hz.

2.2 CONTROLS

A. Pipe-Mounted Thermostats for Freeze Protection:

1. Remote bulb temperature-control unit with adjustable range from 30 to 50 deg F.
2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
3. Remote temperature-sensing bulb on capillary, resistance temperature device, or thermistor for directly sensing ambient air or pipe-wall temperature.
4. Corrosion-resistant, waterproof control enclosure.

2.3 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install electric heating cable at locations indicated and in accordance with NFPA 70.

B. Install electric heating cable across expansion, construction, and control joints in accordance with manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

C. Install electric heating cables after piping has been tested and before insulation is installed.

D. Install electric heating cables in accordance with IEEE 515.1.

E. Install insulation over piping with electric cables in accordance with Section 230719 "HVAC Piping Insulation."

F. Install warning tape on piping insulation where piping is equipped with electric heating cables.

G. Set field-adjustable switches and circuit-breaker trip ranges.

H. Install temperature-control units in an accessible location and in accordance with the manufacturer’s written instructions. Locate sensing bulbs to sense outside air temperature in a location where it will not be affected by direct sunlight or other heat sources.

I. Install outside air and pipe temperature sensors.

3.3 ELECTRICAL CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Connect temperature-control unit to interrupt power supply to electric heating cable when outside air is above set point.

D. Connect remote electronic temperature sensors.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Perform tests after cable installation but before application of coverings, such as insulation, wall or ceiling construction, or concrete.
2. Test cables for electrical continuity and insulation integrity before energizing.
3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

C. Cables will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 PROTECTION

A. Protect installed heating cables, including nonheating leads, from damage.

B. Remove and replace damaged heat-tracing cables.

END OF SECTION 230533

SECTION 230546 - COATINGS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes application of coating systems on internal HVAC components and external equipment surfaces, including the following systems:

1. Air-dried corrosion-resistant coating systems.

1.2 DEFINITIONS

A. Salt Water Acetic Acid Test (SWAAT): A salt fog-spray test of corrosion resistance performed in accordance with ASTM G85, Annex 3.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include Safety Data Sheets, preparation requirements, and application instructions.

1.4 INFORMATIONAL SUBMITTALS

A. Source Quality-Control Reports:

1. Certification of coating material testing.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Coatings: 1 container of each material and color applied, including base coat and top coat products.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in clean, dry, well-ventilated areas with ambient temperatures continuously maintained between 50 and 75 deg F.

1. Keep containers out of direct sunlight; avoid excessive heat and keep from freezing.
2. Maintain containers in clean condition, free of foreign materials and residue.
3. Remove rags and waste from storage areas daily.

1.7 CONDITIONS FOR COATING APPLICATION

A. Comply with manufacturer's recommendations regarding required temperature and humidity ranges during coating application.

PART 2 - PRODUCTS

2.1 CORROSION-RESISTANT COATING SYSTEMS, GENERAL

A. Material Compatibility:

1. Provide materials for application within each coating system that are compatible with one another and with metal substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coating material in coating system, submit compatibility certification from manufacturer of each coating product that products are compatible with substrate base material and with substrate-coating products applied as earlier coats.

B. Colors: Manufacturer’s standard.

2.2 CORROSION-RESISTANT COATING SYSTEMS

A. Refer to drawing schedules for coatings and performance requirements.

2.3 SOURCE QUALITY CONTROL

A. Certification of Coating Material Testing: Submit manufacturer's test report of corrosion-resistance performance testing, as performed by a nationally recognized testing laboratory.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with coating manufacturer's requirements and other conditions affecting performance of the Work.

B. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

C. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions applicable to substrates and coating systems indicated.

1. Thinning: Thin coating material with manufacturer's recommended thinning products when recommended or permitted by coating system manufacturer.

B. Comply with coating system manufacturer's recommendations to clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

3.3 APPLICATION

A. Verify with coating manufacturer whether coatings required must be applied and cured in factory-certified application shop.

B. Apply coating systems with equipment designed to deposit coating of specified uniform thickness over HVAC components, in complex, three-dimensional geometries.

1. Apply coatings with manufacturer-recommended tools and techniques suited for specified coating system and each coated HVAC component.
2. Do not apply coatings over labels or equipment name, identification, performance rating, or nomenclature plates.

C. Perform inspection and coating system manufacturer's recommended tests to verify coating integrity and thickness. Where coating was damaged by testing, repair damage in accordance with coating system manufacturer's written recommendations.

END OF SECTION 230546

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SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning tape.
3. Pipe labels.
4. Valve tags.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve-numbering scheme.

E. Valve Schedules: Provide for each piping system. Include in operation and maintenance manuals.

PART 2 - PRODUCTS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.
2. Letter and Background Color: As indicated for specific application under Part 3.
3. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
6. Fasteners: Stainless steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

2.2 WARNING TAPE

A. Material: Vinyl.

B. Minimum Thickness: 0.005 inch.

C. Letter, Pattern, and Background Color: As indicated for specific application under Part 3.

D. Waterproof Adhesive Backing: Suitable for indoor or outdoor use.

E. Maximum Temperature: 160 deg F.

F. Minimum Width: 2 inches.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.

B. Letter and Background Color: As indicated for specific application under Part 3.

C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:

1. Pipe size.
2. Flow-Direction Arrows: Include flow-direction arrows on[**main**] distribution piping. Arrows may be either integral with label or applied separately.
3. Lettering Size: Size letters in accordance with ASME A13.1 for piping.

2.4 VALVE TAGS

A. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: stainless steel, 0.024-inch minimum thickness, with predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass stainless-steel wire.

B. Letter and Background Color: As indicated for specific application under Part 3.

C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Include valve-tag schedule in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION, GENERAL REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS

A. Permanently fasten labels on each item of mechanical equipment.

1. White letters on an ANSI Z535.1 safety-blue background.

B. Locate equipment labels where accessible and visible.

C. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where arc-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.

3.4 INSTALLATION OF WARNING TAPE

A. Warning Tape Color and Pattern: Yellow background with black diagonal stripes.

B. Install warning tape on pipes and ducts, with cross-designated walkways providing less than 6 ft. of clearance.

C. Locate tape so as to be readily visible from the point of normal approach.

3.5 INSTALLATION OF PIPE LABELS

A. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

B. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Within 3 ft. of each valve and control device.
2. At access doors, manholes, and similar access points that permit view of concealed piping.
3. Within 3 ft. of equipment items and other points of origination and termination.
4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping, ductwork, and equipment.

C. Flow-Direction Arrows: Use arrows to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

D. Pipe-Label Color Schedule:

1. Chilled-Water Piping: White letters on an ANSI Z535.1 safety-green background.
2. Heating Water Piping: White letters on an ANSI Z535.1 safety-green background.
3. Refrigerant Piping: White letters on an ANSI Z535.1 safety-blue background.

3.6 INSTALLATION OF VALVE TAGS

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule in the operating and maintenance manual.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below.

1. Valve-Tag Size and Shape:

a. Chilled Water: 1-1/2 inches, round.
b. Hot Water: 1-1/2 inches, round.

2. Valve-Tag Colors:

a. For each piping system, use the same lettering and background coloring system on valve tags as used for the Pipe Label Schedule text and background.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Testing, Adjusting, and Balancing of Air Systems:

    a. Constant-volume air systems.
    b. Variable-air-volume systems.

2. Testing, Adjusting, and Balancing of Hydronic Piping Systems:

    a. Constant-flow hydronic systems.
    b. Variable-flow hydronic systems.
    c. Primary-secondary hydronic systems.

3. Testing, adjusting, and balancing of fuel oil systems for HVAC.
4. Testing, adjusting, and balancing of equipment.
5. Duct leakage tests verification.
6. Pipe leakage tests verification.
7. HVAC-control system verification.

1.2 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. TAB: Testing, adjusting, and balancing.

C. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

D. TDH: Total dynamic head.

E. UFAD: Underfloor air distribution.

1.3 PREINSTALLATION MEETINGS

A. TAB Conference: Conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.

1. Minimum Agenda Items:

    a. The Contract Documents examination report.
    b. The TAB plan.
    c. Needs for coordination and cooperation of trades and subcontractors.
    d. Proposed procedures for documentation and communication flow.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 90 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 90 days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.

C. Strategies and Procedures Plan: Within 90 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.

D. System Readiness Checklists: Within 90 days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.

E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

F. Certified TAB reports.

G. Sample report forms.

H. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.5 QUALITY ASSURANCE

A. TAB Specialists Qualifications, Certified by AABC:

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
2. TAB Technician: Employee of the TAB specialist and certified by AABC.

B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

D. Code and AHJ Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.6 FIELD CONDITIONS

A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for HVAC to verify that they are properly separated from adjacent areas and sealed.

F. Examine equipment performance data, including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainer baskets are installed and clean.

L. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Examine control dampers for proper installation for their intended function of isolating, throttling, diverting, or mixing air flows.

Q. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:

    a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
    b. Duct systems are complete with terminals installed.
    c. Volume, smoke, and fire dampers are open and functional.
    d. Clean filters are installed.
    e. Fans are operating, free of vibration, and rotating in correct direction.
    f. Variable-frequency controllers' startup is complete and safeties are verified.
    g. Automatic temperature-control systems are operational.
    h. Ceilings are installed.
    i. Windows and doors are installed.
    j. Suitable access to balancing devices and equipment is provided.

2. Hydronics:

    a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
    b. Piping is complete with terminals installed.
    c. Water treatment is complete.
    d. Systems are flushed, filled, and air purged.
    e. Strainers are pulled and cleaned.
    f. Control valves are functioning in accordance with the sequence of operation.
    g. Shutoff and balance valves have been verified to be 100 percent open.
    h. Pumps are started and proper rotation is verified.
    i. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
    j. Variable-frequency controllers' startup is complete and safeties are verified.
    k. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system in accordance with the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.

B. Cut insulation, ducts, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
2. Where holes for probes are required in piping or hydronic equipment, install pressure and temperature test plugs to seal systems.
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 TESTING, ADJUSTING, AND BALANCING OF HVAC EQUIPMENT

A. Test, adjust, and balance HVAC equipment indicated on Drawings, including, but not limited to, the following:

1. Motors.
2. Pumps.
3. Fans and ventilators.
4. Terminal units.
5. Unit heaters.
6. Heat exchangers.
7. Water chillers.
8. Air-handling units.
9. Rooftop air-conditioning units.
10. Variable-refrigerant-flow systems.
11. Coils.
12. Fan coil units.

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' Record drawings duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

    a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
    c. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

2. Measure fan static pressures as follows:

    a. Measure static pressure directly at the fan outlet or through the flexible connection.
    b. Measure static pressure directly at the fan inlet or through the flexible connection.
    c. Measure static pressure across each component that makes up the air-handling system.
    d. Report artificial loading of filters at the time static pressures are measured.

3. Review Contractor-prepared shop drawings and Record drawings to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
4. Obtain approval from the Construction Manager for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlets and outlets airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, speed, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.7 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:

    a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
    b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
    c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
    d. Adjust controls so that terminal is calling for minimum airflow.
    e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
    f. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.

5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturers.

    a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow, so that connected total matches fan selection and simulates actual load in the building.
    c. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
    d. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

6. Measure fan static pressures as follows:

    a. Measure static pressure directly at the fan outlet or through the flexible connection.
    b. Measure static pressure directly at the fan inlet or through the flexible connection.
    c. Measure static pressure across each component that makes up the air-handling system.
    d. Report any artificial loading of filters at the time static pressures are measured.

7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

    a. Balance the return-air ducts and inlets.
    b. Verify that terminal units are meeting design airflow under system maximum flow.

8. Re-measure the inlet static pressure at the most critical terminal unit, and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls Contractor.
9. Verify final system conditions as follows:

    a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
    b. Re-measure and confirm that total airflow is within design.
    c. Re-measure final fan operating data, speed, volts, amps, and static profile.
    d. Mark final settings.
    e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
    f. Verify tracking between supply and return fans.

3.8 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for pumps, coils, and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and equipment flow rates with pump design flow rate.

B. Prepare schematic diagrams of systems' Record drawings piping layouts.

C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:

1. Check expansion tank for proper setting.
2. Check highest vent for adequate pressure.
3. Check flow-control valves for proper position.
4. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
5. Verify that motor controllers are equipped with properly sized thermal protection.
6. Check that air has been purged from the system.

D. Measure and record upstream and downstream pressure of each piece of equipment.

E. Measure and record upstream and downstream pressure of pressure-reducing valves.

F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.

1. Check settings and operation of each safety valve. Record settings.

3.9 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Adjust pumps to deliver total design flow.

1. Measure total water flow.

    a. Position valves for full flow through coils.
    b. Measure flow by main flow meter, if installed.
    c. If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.

2. Measure pump TDH as follows:

    a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
    b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
    c. Convert pressure to head and correct for differences in gauge heights.
    d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
    e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.

3. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.

B. Adjust flow-measuring devices installed in mains and branches to design water flows.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

C. Adjust flow-measuring devices installed at terminals for each space to design water flows.

1. Measure flow at terminals.
2. Adjust each terminal to design flow.

3. Re-measure each terminal after it is adjusted.
4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
5. Perform temperature tests after flows have been balanced.

D. For systems with pressure-independent valves at terminals:

1. Measure differential pressure and verify that it is within manufacturer's specified range.
2. Perform temperature tests after flows have been verified.

E. For systems without pressure-independent valves or flow-measuring devices at terminals:

1. Measure and balance coils by either coil pressure drop or temperature method.
2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

F. Verify final system conditions as follows:

1. Re-measure and confirm that total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
3. Mark final settings.

G. Verify that memory stops have been set.

3.10 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.

B. Adjust the variable-flow hydronic system as follows:

1. Verify that the pressure-differential sensor(s) is located as indicated.
2. Determine whether there is diversity in the system.

C. For systems with no flow diversity:

1. Adjust pumps to deliver total design flow.

a. Measure total water flow.

1) Position valves for full flow through coils.
2) Measure flow by main flow meter, if installed.
3) If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.

b. Measure pump TDH as follows:

1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
3) Convert pressure to head and correct for differences in gauge heights.

4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
5) With valves open, read pump TDH. Adjust pump discharge valve or speed until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.

c. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.

2. Adjust flow-measuring devices installed in mains and branches to design water flows.

a. Measure flow in main and branch pipes.
b. Adjust main and branch balance valves for design flow.
c. Re-measure each main and branch after all have been adjusted.

3. Adjust flow-measuring devices installed at terminals for each space to design water flows.

a. Measure flow at terminals.
b. Adjust each terminal to design flow.
c. Re-measure each terminal after it is adjusted.
d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
e. Perform temperature tests after flows have been balanced.

4. For systems with pressure-independent valves at terminals:

a. Measure differential pressure and verify that it is within manufacturer's specified range.
b. Perform temperature tests after flows have been verified.

5. For systems without pressure-independent valves or flow-measuring devices at terminals:

a. Measure and balance coils by either coil pressure drop or temperature method.
b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

6. Prior to verifying final system conditions, determine the system pressure-differential set point(s).
7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion, open discharge valve 100 percent, and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
8. Mark final settings and verify that all memory stops have been set.
9. Verify final system conditions as follows:

a. Re-measure and confirm that total flow is within design.
b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
c. Mark final settings.

D. For systems with flow diversity:

1. Determine diversity factor.
2. Simulate system diversity by closing required number of control valves, as approved by Architect.
3. Adjust pumps to deliver total design flow.

    a. Measure total water flow.

        1) Position valves for full flow through coils.
        2) Measure flow by main flow meter, if installed.
        3) If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.

    b. Measure pump TDH as follows:

        1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
        2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
        3) Convert pressure to head and correct for differences in gauge heights.
        4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
        5) With valves open, read pump TDH. Adjust pump discharge valve or speed until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.

    c. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.

4. Adjust flow-measuring devices installed in mains and branches to design water flows.

    a. Measure flow in main and branch pipes.
    b. Adjust main and branch balance valves for design flow.
    c. Re-measure each main and branch after all have been adjusted.

5. Adjust flow-measuring devices installed at terminals for each space to design water flows.

    a. Measure flow at terminals.
    b. Adjust each terminal to design flow.
    c. Re-measure each terminal after it is adjusted.
    d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
    e. Perform temperature tests after flows have been balanced.

6. For systems with pressure-independent valves at terminals:

    a. Measure differential pressure, and verify that it is within manufacturer's specified range.
    b. Perform temperature tests after flows have been verified.

7. For systems without pressure-independent valves or flow-measuring devices at terminals:

a. Measure and balance coils by either coil pressure drop or temperature method.
b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
9. Prior to verifying final system conditions, determine system pressure-differential set point(s).
10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion, open discharge valve 100 percent, and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:

a. Re-measure and confirm that total water flow is within design.
b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
c. Mark final settings.

3.11 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first.

B. Balance the secondary circuits after the primary circuits are complete.

C. Adjust pumps to deliver total design flow.

1. Measure total water flow.

a. Position valves for full flow through coils.
b. Measure flow by main flow meter, if installed.
c. If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.

2. Measure pump TDH as follows:

a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
c. Convert pressure to head and correct for differences in gauge heights.
d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
e. With valves open, read pump TDH. Adjust pump discharge valve or speed until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.

3. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.

D. Adjust flow-measuring devices installed in mains and branches to design water flows.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

E. Adjust flow-measuring devices installed at terminals for each space to design water flows.

1. Measure flow at terminals.
2. Adjust each terminal to design flow.
3. Re-measure each terminal after it is adjusted.
4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
5. Perform temperature tests after flows have been balanced.

F. For systems with pressure-independent valves at terminals:

1. Measure differential pressure and verify that it is within manufacturer's specified range.
2. Perform temperature tests after flows have been verified.

G. For systems without pressure-independent valves or flow-measuring devices at terminals:

1. Measure and balance coils by either coil pressure drop or temperature method.
2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

H. Verify final system conditions as follows:

1. Re-measure and confirm that total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
3. Mark final settings.

I. Verify that memory stops have been set.

3.12 PROCEDURES FOR WATER-TO-WATER HEAT EXCHANGERS

A. Adjust and record water flow to within specified tolerances.

B. Measure and record inlet and outlet water temperatures.

C. Measure and record pressure drop.

D. Check and record settings and operation of safety and relief valves.

3.13 PROCEDURES FOR MOTORS

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter size and thermal-protection-element rating.

8. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.14 PROCEDURES FOR WATER CHILLERS

A. Air-Cooled Chillers: Balance water flow through each evaporator to within specified tolerances of indicated flow, with all pumps operating. With only one chiller operating in a multiple-chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
2. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
3. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
4. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
5. Capacity: Calculate in tons of cooling.
6. Efficiency: Calculate operating efficiency for comparison to submitted equipment.
7. Verify condenser-fan rotation and record fan and motor data, including number of fans and entering- and leaving-air temperatures.

3.15 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each hydronic coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Entering and leaving refrigerant pressure and temperatures.

3.16 DUCT LEAKAGE TESTS

A. Witness the duct leakage testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified limits.

C. Report deficiencies observed.

3.17 PIPE LEAKAGE TESTS

A. Witness the pipe pressure testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified limits.

C. Report deficiencies observed.

3.18 HVAC CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify HVAC control system is operating within the design limitations.
2. Confirm that the sequences of operation are in compliance with Contract Documents.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.19 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 10 percent or minus 5 percent. If design value is less than 100 cfm, within 10 cfm.
2. Air Outlets and Inlets: Plus 10 percent or minus 5 percent. If design value is less than 100 cfm, within 10 cfm.
3. Heating-Water Flow Rate: Plus or minus 5 percent. If design value is less than 10 gpm, within 10 percent.
4. Chilled-Water Flow Rate: Plus or minus 5 percent. If design value is less than 10 gpm, within 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.20 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance-measuring and -balancing devices.

3.21 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents, including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans performance forms, including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Heating coil, dry-bulb conditions.
    e. Face and bypass damper settings at coils.
    f. Fan drive settings, including settings and percentage of maximum pitch diameter.
    g. Variable-frequency controller settings for variable-air-volume systems.
    h. Settings for pressure controller(s).
    i. Other system operating conditions that affect performance.

16. Test conditions for pump performance forms, including the following:

a. Variable-frequency controller settings for variable-flow hydronic systems.
b. Settings for pressure controller(s).
c. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units, include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches, and bore.
i. Center-to-center dimensions of sheave and amount of adjustments in inches.
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and speed.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan speed.
d. Inlet and discharge static pressure in inches wg.
e. For each filter bank, filter static-pressure differential in inches wg.
f. Preheat-coil static-pressure differential in inches wg.
g. Cooling-coil static-pressure differential in inches wg.
h. Heating-coil static-pressure differential in inches wg.
i. List for each internal component with pressure-drop, static-pressure differential in inches wg.
j. Outdoor airflow in cfm.
k. Return airflow in cfm.
l. Outdoor-air damper position.

m. Return-air damper position.
n. [**Vortex damper position**].

F. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch o.c.
f. Make and model number.
g. Face area in sq. ft..
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. Water flow rate in gpm.
i. Water pressure differential in feet of head or psig.
j. Entering-water temperature in deg F.
k. Leaving-water temperature in deg F.

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and speed.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave and amount of adjustments in inches.
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan speed.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System fan and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft..
g. Indicated airflow rate in cfm.
h. Indicated velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

I. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft..

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Air velocity in fpm.
c. Preliminary airflow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final airflow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

J. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

a. System and air-handling-unit identification.
b. Location and zone.

c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Entering-water temperature in deg F.
c. Leaving-water temperature in deg F.
d. Water pressure drop in feet of head or psig.
e. Entering-air temperature in deg F.
f. Leaving-air temperature in deg F.

K. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves, and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm.
g. Water pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump speed.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

L. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.

c. Application.
d. Dates of use.
e. Dates of calibration.

3.22 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Construction Manager.

B. Architect shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.

E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.
2. If the second final inspection also fails, Owner may pursue others Contract options to complete TAB work.

F. Prepare test and inspection reports.

3.23 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following duct services:

1. Outdoor, exposed supply and return.

B. Related Requirements:

1. Section 233113 "Metal Ducts" for duct liners."
2. Section 230719 "HVAC Piping Insulation."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or craft training program.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers are to be marked with the manufacturer's name, appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials are to be applied.

B. Products do not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric: Closed-cell or expanded-rubber materials; suitable for maximum use temperature between minus 70 deg F and 220 deg F. Comply with ASTM C534, Type II for sheet materials.

2.3 ADHESIVES

A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

2.4 SEALANTS

A. Metal Jacket Flashing Sealants:

1. Materials are compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.

2.5 FIELD-APPLIED JACKETS

A. Field-applied jackets comply with ASTM C921, Type I, unless otherwise indicated.

B. Metal Jacket:

1. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

a. Sheet and roll stock ready for shop or field sizing.
b. Finish and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Outdoor Applications: 3-mil-thick polysurlyn.

2.6 SECUREMENTS

A. Bands:

1. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.

2.7 CORNER ANGLES

A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum in accordance with ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with Contract Documents.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at [**2 inches**] [**4 inches**] o.c.

a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Comply with manufacturer's written installation instructions and ASTM C1710.

B. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Square and Rectangular Ducts and Plenums:

1. Provide 1/4 inch more per side for a tight, compression fit.
2. Cut sheet insulation with the following dimensions:

a. Width of duct plus 1/4 inch, one piece.
b. Height of duct plus 1/4 inch, plus thickness of insulation, two pieces.
c. Width of duct plus 1/4 inch, plus two times the thickness of insulation, one piece.

3. Insulate the bottom of the duct with the sheet from (a) above, then the sides with the two sheets from (b) above, and finally the top of the duct with the sheet from (c) above.
4. Insulation without self-adhering backing:

a. Apply 100 percent coverage of manufacturer adhesive on the metal surface, then the insulation, except for the last 1/4 inch where sheets will butt together.
b. Roll sheet down into position.

c. Press two sheets together under compression and apply adhesive at the butt joint to seal the two sheets together.

5. Insulation with self-adhering backing:

a. Peel back release paper in 6- to 8-inch increments and line up sheet.
b. Press firmly to activate adhesive.
c. Align material and continue to line up correctly, pressing firmly while slowly removing release paper.
d. Allow 1/4-inch overlap for compression at butt joints.
e. Apply adhesive at the butt joint to seal the two sheets together.

6. Insulate duct brackets following manufacturer's written installation instructions.

3.6 FIELD-APPLIED JACKET INSTALLATION

A. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

3.7 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

C. Do not field paint aluminum jackets.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.9 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Outdoor, exposed supply and return.

B. Items Not Insulated:

1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
2. Factory-insulated plenums and casings.
3. Flexible connectors.
4. Factory-insulated access panels and doors.

3.10 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.

B. Exposed, rectangular, supply-air duct insulation is the following:

1. Flexible Elastomeric: 2 inches.

C. Exposed, rectangular, return-air duct insulation is the following:

1. Flexible Elastomeric: 2 inches.

3.11 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. Painted Aluminum, Corrugated: 0.032 inch thick.

END OF SECTION 230713

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SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. The section includes insulation for HVAC piping systems.

B. Related Requirements:

1. Section 230713 "Duct Insulation" for duct insulation.
2. Section 232113.13 "Underground Hydronic Piping" loose-fill pipe insulation in underground piping outside the building.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied, if any).

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or craft training program.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include name of manufacturer, fabricator, type, description, and size.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84 by a testing agency acceptable to authority having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials are applied.

B. Products do not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric: Closed-cell, or expanded-rubber materials; suitable for maximum use temperature between minus 70 deg F and 220 deg F. Comply with ASTM C534/C534M, Type I, for tubular materials, Type II for sheet materials.

2.3 ADHESIVES

A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.

1. Flame-spread index is 25 or less and smoke-developed index is 50 or less as tested in accordance with ASTM E84.
2. Wet Flash Point: Below 0 deg F.
3. Service Temperature Range: 40 to 200 deg F.
4. Color: Black.

C. PVC Jacket Adhesive: Compatible with PVC jacket.

2.4 SEALANTS

A. Materials are as recommended by the insulation manufacturer and are compatible with insulation materials, jackets, and substrates.

B. Joint Sealants:

1. Permanently flexible, elastomeric sealant.

a. Service Temperature Range: Minus 100 to plus 300 deg F.
b. Color: White or gray.

C. Metal Jacket Flashing Sealants:

1. Fire- and water-resistant, flexible, elastomeric sealant.
2. Service Temperature Range: Minus 40 to plus 250 deg F.
3. Color: Aluminum.

D. PVC Jacket Flashing Sealants:

1. Fire- and water-resistant, flexible, elastomeric sealant.
2. Service Temperature Range: Minus 40 to plus 250 deg F.
3. Color: White.

2.5 FIELD-APPLIED JACKETS

A. Field-applied jackets comply with ASTM C1136, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.
2. Color: White.
3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

C. Metal Jacket:

1. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

a. Sheet and roll stock ready for shop or field sizing.
b. Finish and thickness are indicated in field-applied jacket schedules.
c. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.

2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2. Stainless Steel Jacket: ASTM A240/A240M.

a. Sheet and roll stock ready for shop or field sizing.
b. Material, finish, and thickness are indicated in field-applied jacket schedules.
c. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.6 TAPES

A. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

2.7 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A240/A240M, Type 316; 0.015 inch thick, 3/4 inch wide with closed seal.
2. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with closed seal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock positions) of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with the Contract Documents.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Cut insulation in a manner to avoid compressing insulation.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles below.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using prefabricated fitting insulation or mitered or routed fittings made from same material and density as that of adjacent pipe insulation. Each piece is butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with prefabricated fitting insulation or sectional pipe insulation of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using prefabricated fitting insulation or sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using prefabricated fitting insulation or sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges, mechanical couplings, and unions using a section of oversized preformed pipe insulation to fit. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers. Installation conforms to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install sections of pipe insulation and miter if required in accordance with manufacturer's written instructions.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated valve covers manufactured of same material as that of pipe insulation when available.
2. When prefabricated valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF FIELD-APPLIED JACKETS

A. Where PVC jackets are indicated and for horizontal applications, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

3.8 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

B. Do not field paint aluminum or stainless steel jackets.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation.

C. All insulation applications may be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.10 PIPING INSULATION SCHEDULE, GENERAL

A. Insulation conductivity and thickness per pipe size comply with schedules in this Section or with requirements of authorities having jurisdiction, whichever is more stringent.

B. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation is the following:

a. Flexible Elastomeric: 3/4 inch thick.

B. Chilled Water and Brine, Above 40 Deg F:

1. NPS 12 and Smaller: Insulation is the following:

a. Flexible Elastomeric: 1 inch thick.

C. Heating-Hot-Water Supply and Return, 200 Deg F and Below:

1. NPS 1-1/2 and Smaller: Insulation is the following:

a. Flexible Elastomeric: 1 inch thick.

2. NPS 2 and Larger: Insulation is the following:

a. Flexible Elastomeric: 1-1/2 inches thick.

3.12 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Chilled Water and Brine:

1. All Pipe Sizes: Insulation is the following:

a. Flexible Elastomeric: 2 inches thick.

B. Heating-Hot-Water Supply and Return, 200 Deg F and Below:

1. All Pipe Sizes: Insulation is the following:

a. Flexible Elastomeric: 2 inches thick.

C. Dual-Service Heating and Cooling:

1. All Pipe Sizes: Insulation is the following:

a. Flexible Elastomeric: 2 inches thick.

3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.

D. Piping, Exposed:

1. PVC: 30 mils thick.

3.14 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.

D. Piping, Exposed:

1. Aluminum, Corrugated: 0.024 inch thick.
2. Stainless Steel, Type 316, Corrugated: 0.020 inch thick.

END OF SECTION 230719

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SECTION 230923 DIRECT - DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish a totally native BACnet-based system. All building controllers, application controllers, and all input/output devices shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135–2008, BACnet. In other words, all workstations and controllers, including unitary controllers, shall be native BACnet devices. No gateways shall be used for communication to controllers installed under this section. Gateways may be used for communication to systems installed under other sections.

B. This system shall be directly interfaced with the existing Alexandria Real Estate Equities BACnet BMS Server and shall be incorporated seamlessly into the existing graphics package and shall match all graphics standards. The existing server has all necessary software and licenses for this interface. All building automation functions for the installed system shall be integrated into the existing Alerton Server. This includes the ability to view, schedule, trend, and alarm all control points through the existing server software.

C. Provide all necessary BACnet-compliant hardware and software to meet the system's functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and every controller in system, including unitary controllers.

C. Prepare individual hardware layouts, interconnection drawings, and software configuration from project design data.

D. Implement the detailed design for all analog and binary objects, system databases, graphic displays, logs, and management reports based on control descriptions, logic drawings, configuration data, and bid documents.

E. Design, provide, and install all equipment cabinets, panels, data communication network cables needed, and all associated hardware.

F. Provide and install all interconnecting cables between supplied cabinets, application controllers, and input/output devices.

G. Provide and install all interconnecting cables between all operator's terminals and peripheral devices supplied under this section.

H. Provide complete manufacturer's specifications for all items that are supplied. Include vendor name of every item supplied.

I. Provide supervisory specialists and technicians at the job site to assist in all phases of system installation, startup, and commissioning.

J. Provide a comprehensive operator and technician training program as described herein.

K. Provide as-built documentation, operator's terminal software, diagrams, and all other associated project operational documentation (such as technical manuals) on approved media, the sum total of which accurately represents the final system.

L. Provide new sensors, dampers, valves, and install only new electronic actuators. No used components shall be used as any part or piece of installed system.

1.2 SYSTEM DESCRIPTION

A. A distributed logic control system complete with all software and hardware functions shall be provided and installed. System shall be completely based on ANSI/ASHRAE Standard 135-2008. This system is to control all mechanical equipment, including all unitary equipment such as VAV boxes, heat pumps, fan-coils, AC units, etc., and all air handlers, boilers, chillers, and any other listed equipment using native BACnet-compliant components. Non-BACnet-compliant or proprietary equipment or systems (including gateways) shall not be acceptable and are specifically prohibited.

B. Operator's workstation software shall use Microsoft Windows 10 or greater as the computer operating system. The Energy Management and Control System (EMCS) application program shall be written to communicate specifically utilizing BACnet protocols. Software functions delivered on this project shall include password protection, scheduling (including optimum start), alarming, logging of historical data, full graphics including animation, after-hours billing program, demand limiting, and a full suite of field engineering tools including graphical programming and applications. Systems using operating systems other than that described above are strictly prohibited. All software required to program application specific controllers and all field level devices and controllers will be left with the owner. All software passwords required to program and make future changes to the system will also become the property of the owner. All software required to make any program changes anywhere in the system, along with scheduling and trending applications, will be left with the owner. All software passwords required to program and make future changes to schedules, trends and related program changes will also become the property of the owner. All software required for all field engineering tools including graphical programming and applications will be left with the owner. All software passwords required to program and make future changes to field engineering tools, including graphical programming and applications will be left with the owner.

C. Building controllers shall include complete energy management software, including scheduling building control strategies with optimum start and logging routines. All energy management software and firmware shall be resident in field hardware and shall not be dependent on the operator's terminal. Operator's terminal software is to be used for access to field-based energy management functions only. Provide zone-by-zone direct digital logic control of space temperature, scheduling, runtime accumulation, equipment alarm reporting, and override timers for after-hours usage.

D. Room sensors shall be provided with digital readout that allow the user to view room temperature, view outside air temperature, adjust the room setpoint within preset limits and set desired override time. User shall also be able to start and stop unit from the digital sensor. Include all necessary wiring and firmware such that room sensor includes field service mode. Field service mode shall allow a technician to balance VAV zones and access any parameter in zone controller directly from the room sensor. Field service mode shall have the ability to be locked out.

E. All application controllers for every terminal unit (VAV, HP, UV, etc.) air handler, all central plant equipment, and any other piece of controlled equipment shall be fully programmable. Application controllers shall be mounted next to controlled equipment and communicate with building controller through BACnet LAN.

1.3 APPROVED MANUFACTURERS

A. The basis of design shall be extending the Hoffman Building Technologies Building Automation System. Listed manufacturers may bid based upon meeting all requirements of the specification.

Approved Control Manufacturers

1. Hoffman Building Technologies

1.4 QUALITY ASSURANCE

A. The Building Automation System (BAS) system shall be designed, installed, commissioned, and serviced by manufacturer authorized and trained personnel. System provider shall have an in-place support facility within 2 hours response time of the site with technical staff, spare parts inventory, and necessary test and diagnostic equipment.

The contractor shall provide full-time, on-site, experienced project manager for this work, responsible for direct supervision of the design, installation, start-up and commissioning of the BAS system.

The Bidder shall be regularly engaged in the design, installation and maintenance of BAS systems and shall have demonstrated technical expertise and experience in the design, installation and maintenance of BAS systems similar in size and complexity to this project. Bidders shall provide a list of at least 10 projects, similar in size and scope to this project completed within the past 3 years.

B. Materials and equipment shall be manufacturer's latest standard design that complies with the specification requirements.

C. All BAS peer-to-peer network controllers, central system controllers and local user displays shall be UL Listed under Standard UL 916, category PAZX.

D. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

E. Control system shall be engineered, programmed and supported completely by representative’s local office that must be within **50 miles** of project site.

1.5 REFERENCE STANDARDS

A. The latest edition of the following standards and codes in effect and amended as of supplier's proposal date, and any applicable subsections thereof, shall govern design and selection of equipment and material supplied:

1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).

2. ANSI/ASHRAE Standard 135-2008, BACnet.

3. Uniform Building Code (UBC), including local amendments.

4. UL 916 Underwriters Laboratories Standard for Energy Management Equipment. Canada and the US.

5. National Electrical Code (NEC).

6. FCC Part 15, Subpart J, Class A.

7. EMC Directive 89/336/EEC (European CE Mark).

8. UL-864 UUKL listing for Smoke Controls for any equipment used in smoke control sequences.

B. City, county, state, and federal regulations and codes in effect as of contract date.

C. Except as otherwise indicated, the system supplier shall secure and pay for all permits, inspections, and certifications required for his work, and arrange for necessary approvals by the governing authorities.

1.6 SUBMITTALS

A. Drawings

1. The system supplier shall submit engineered drawings, control sequence, and bill of materials for approval.

2. Drawings shall be submitted in the following standard sizes: 8” x 11 1/2” (ANSI B).

3. Drawings shall be available on USB or other digital media.

4. Print copies shall be provided upon request (in an effort to reduce the environmental impact, digital format will be the primary delivery method for submittals)

B. System Documentation

Include the following in submittal package:

1. System configuration diagrams in simplified block format.

2. All input/output object listings and an alarm point summary listing.

3. Electrical drawings that show all system internal and external connection points, terminal block layouts, and terminal identification.

4. Complete bill of materials, valve schedule and damper schedule.

5. Manufacturer's instructions and drawings for installation, maintenance, and operation of all purchased items.

6. Overall system operation and maintenance instructions—including preventive maintenance and troubleshooting instructions.

7. For all system elements—operator’s workstation(s), building controller(s), application controllers, routers, and repeaters—provide BACnet Protocol Implementation Conformance Statements (PICS) as per ANSI/ASHRAE Standard 135-2001.

8. Provide complete description and documentation of any proprietary (non-BACnet) services and/or objects used in the system.

9. A list of all functions available and a sample of function block programming that shall be part of delivered system.

C. Project Management

1. The vendor shall provide a detailed project design and installation schedule with time markings and details for hardware items and software development phases. Schedule shall show all the target dates for transmission of project information and documents, and shall indicate timing and dates for system installation, debugging, and commissioning.

1.7 WARRANTY

A. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of one year from completion of system acceptance.

B. Hardware and software personnel supporting this warranty agreement shall provide on-site or

off-site service in a timely manner after failure notification to the vendor. The maximum acceptable response time to provide this service at the site shall be 24 hours, Monday through Friday and 48 hours on Saturday and Sunday.

C. This warranty shall apply equally to both hardware and software.

1.8 RELATED WORK IN OTHER SECTIONS

A. Refer to Division 0 and Division 1 for related contractual requirements.

B. Refer to Section 230000 for General Mechanical Provisions.

C. Refer to Section 260000 for General Electrical Provisions.

PART 2 - PRODUCTS

2.1 Advanced Workstation (AWS) - Existing

A. General structure of workstation interaction shall be a standard client/server relationship with web server embedded in the server for browser only access. Server shall be used to archive data and store system database. The AWS shall support operation in a virtualized server environment. Thick and web clients shall access server for all archived data.

1. A single server license shall:

a. Allow a minimum of 50 thick client seats/installations.

b. Allow a minimum of 200 web client users.

c. Not restrict system size based on point count (BACnet or Integration).

B. Data Displays

1. Data displays shall render all data associated with project as called out on drawings and/or object type list supplied. Graphic files shall be created using digital, full color photographs of system installation, AutoCAD or Visio drawing files of field installation drawings, and wiring diagrams from as-built drawings.

2. Data displays shall render data using iconic graphic representations of all mechanical equipment. System shall be capable of displaying graphic file, text, trendlog, and dynamic object data together on each display and shall include animation. Information shall be labeled with descriptors and shall be shown with the appropriate engineering units. All information on any display shall be dynamically updated without any action by the user.

3. Data display frame shall allow user to change all field-resident AWS functions associated with the project, such as setpoints, weekly schedules, exception schedules, etc., from any screen, no matter if that screen shows all text or a complete graphic display. This shall be done without any reference to object addresses or other numeric/mnemonic indications.

4. Analog objects shall be displayed with operator modifiable units. Analog input objects may also be displayed as individual graphic items on the display screen as an overlay to the system graphic.

5. All displays and programming shall be generated and customized by the local use energy management and control system (EMCS) supplier and installer. Systems requiring factory development of graphics or programming of DDC logic are specifically prohibited.

6. AWS shall be supplied with a library of standard graphics, which may be used unaltered or modified by the operator. AWS shall include a library of equipment graphic components to assemble custom graphics. Systems that do not allow customization or creation of new graphic objects by the operator (or with third-party software) shall not be allowed.

7. A navigation tree for building, equipment and system diagnostic centric display organization shall be available from data display view. The tree navigation contents shall be customizable on a per-user and per-group basis.

8. Each display may be protected from viewing unless operator credentials have the appropriate access level. An access level may be assigned to each display and system object. The menu label shall not appear on the graphic if the operator does not have the appropriate security level.

9. Data displays shall have the ability to link to content outside of the EMCS system. Such content shall include, but is not limited to launching external files in their native applications (for example, a Microsoft Word document).

10. A single system software license can support a minimum of 200 user accounts and web access.

11. Data displays shall support:

    a. Graphic items with custom geometry that offer both color gradient shading and variable opacity in scale to system variables, both analog and digital, and color range settings. For example, rooms on a floor plan graphic can be made to indicate the space temperature by varying the color of that room.

    b. Clear and custom geometry navigation buttons to provide intuitive navigation to system display or external URLs.

    c. Graphic files in JPG, PNG, and GIF file types.

    d. Viewing of up to 1,024 system data points (Analog, Binary, and/or Multi-state) in a single screen.

    e. Customizable mouse-over tooltip information of graphic items or data points can be displayed. The tooltips can be turned on and off. The default setting is off.

    f. Right click capability to directly access system functionality, such as Schedule, Trendlogs, and Alarms associated with a display object selected.

    g. Automatic zooming to the screen size detected to maximize the size of the display to match screen display area available. The zoom capability can be enabled or disabled, default is enabled. The background color, if solid, will be used to flood fill the remaining screen background.

    h. Supports user configurable embedded Data Viewer for a persistent trend log data view to accompany system data and graphic information on a single display.

C. Password Protection

1. Provide security system that prevents unauthorized use unless operator is logged on. Access shall be limited to operator's assigned functions when user is logged on. This includes displays as outlined above.

2. AWS shall provide security for a minimum of 200 users. Each user shall have an individual User ID, User Name, and Password. Entries are alphanumeric characters only and are case sensitive (except for User ID). User ID, User Name, and Password shall be shall support a minimum of 40 characters. All user information and passwords shall be stored in an encrypted form.

3. Each user shall be allowed individual assignment of only those control functions, menu items, navigation tree, and user-specific system start display, as well as restricted access to *discrete BACnet devices* to which that user requires access.

4. All passwords, user names, and access assignments shall be adjustable via Server and Thick client. Password shall be adjustable via the web client.

5. Users shall also have a set access level, which defines access to displays and individual objects the user may control. System shall include 10 separate and distinct access levels for assignment to users.

6. The AWS and Thick Client shall include an Auto Logout feature that shall automatically logout user when there has been no keyboard or mouse activity for a set period of time. Time period shall be adjustable by system administrator. Auto Logout may be enabled and disabled by system administrator. Operator terminal shall display message on screen that user is logged out after Auto Logout occurs.

7. The system shall permit the assignment of an effective date range, as well as an effective time of day, that the User IDs are permitted to authenticate.

D. Operator Activity Log

1. An Operator Activity Log that tracks all operator changes and activities shall be included with AWS. System shall track what is changed in the system, who performed this change, date and time of system activity, and value of the change before and after operator activity. Operator shall be able to display all activity, sort the changes by user and also by operation. Operator shall be able to print the Operator Activity Log display.

2. Log shall be gathered and archived to a hard drive on AWS as needed. Operator shall be able to export data for display and sorting in a spreadsheet.

3. System shall have the option to require user comment recording in the Operator Activity Log upon any system point change.

4. Operator Activity log shall be accessible via the Web Client for viewing, sorting, filtering, and Printing.

E. Scheduling

1. AWS, Thick Client and Web Client shall show all information in easy-to-read daily format including calendar of this month and next. All schedules shall show actual ON/OFF times for day based on scheduling priority. Priority for scheduling shall be events, holidays and daily, with events being the highest.

2. Holiday and special event schedules shall display data in calendar format. Operator shall be able to schedule holidays and special events directly from these calendars.

3. Operator shall be able to change all information for a given weekly or exception schedule

if logged on with the appropriate access privileges.

4. AWS and Thick Client shall include a Schedule Wizard for set up of schedules. Wizard shall walk user through all steps necessary for schedule generation. Wizard shall have its own pull-down selection for startup or may be started by right-clicking on value displayed on graphic and then selecting Schedule.

5. Scheduling shall include optimum start based on outside air temperature, current heating/cooling setpoints, indoor temperature and history of previous starts. Each and every individual zone shall have optimum start time independently calculated based on all parameters listed. User shall input schedules to set time that occupied setpoint is to be attained. Optimum start feature shall calculate the startup time needed to match zone temperature to setpoint. User shall be able to set a limit for the maximum startup time allowed.

6. Schedule list shall show all schedules currently defined. This list shall include all standard, holiday and event schedules. In addition, user shall be able to select a list that shows all scheduled points and zones.

7. Display of all three schedules must show all ON times for standard, holiday and event schedules in different colors on a given day. In addition, OFF times for each must also be shown in additional colors. User shall be able to select from standard calendar what days are to be scheduled and same display shall show all points and zones affected. User shall be able to set time for one day and select all days of the week that shall be affected as a recurrence of that same schedule for that given day.

8. Any displayed data that is changeable by the operator may be selected using the right mouse button and the schedule shall then be selectable on the screen. Selection of the schedule using this method shall allow the viewing of the assigned schedule allow the point to be scheduled.

9. Schedule editor shall support drag-n-drop events and holidays onto the schedule calendar.

10. Schedule editor shall support drag-n-drop events default to a two-hour period, which can then be adjusted by the user.

11. Schedule editor shall support drag-n-drop holidays default for OFF all day and can be edited for multiple-day holidays.

12. Schedule editor shall support the view of affected zones when adding or editing timed events of a schedule.

13. The web client shall have the ability to search a list of all scheduled points and zones to access the schedule calendar.

14. Schedule time blocks shall present schedule detail via mouse-over information.

F. Alarm Indication and Handling

1. AWS shall provide visual, printed, and email means of alarm indication. Printout of alarms shall be sent to the assigned terminal and port. Alarm notification can be filtered based on the User ID’s authorization level.

2. Web client shall display a persistent alarm state for the system regardless of the data view including points in alarm but not acknowledged, and points that have gone into alarm and returned to normal without being acknowledged.

3. Alarm History shall provide log of alarm messages. Alarm log shall be archived to the hard

disk of the AWS. Each entry shall include a description of the event-initiating object generating the alarm. Description shall be an alarm message of at least 256 characters in length. Entry shall include time and date of alarm occurrence, time and date of object state return to normal, time and date of alarm acknowledgment, and identification of operator acknowledging alarm.

4. Alarm messages shall be in user-definable text (English or other specified language) and shall be delivered either to the operator's terminal, client or through remote communication using email (Authenticated SMTP supported).

5. AWS, Thick Client, and Web Client shall allow for set up of alarms. UI shall walk user through all steps necessary for alarm generation. Alarm creation may be started by right-clicking on value displayed on graphic and then selecting Alarm setup.

6. Web client shall support color-coded indication of current alarms as follows:

    i. Red indicator shows number of active alarms that have not been acknowledged.

    j. Yellow indicator shows number of alarms that are still active but have been acknowledged.

    k. Blue indicator shows number of alarms that have returned to normal but have not been acknowledged.

    l. Color-coded indicators, when selected by the user, navigate to a pre-filtered view of alarm history.

    m. Alarm history can be filtered by color-coded indicator states.

7. Alarm annunciation includes navigation link to a user-selected display or URL.

8. Any displayed data that is changeable by the operator may be selected using the right mouse button and the alarm shall then be selectable on the screen. Selection of the alarm using this method shall allow the viewing of the alarm history or allow the creation of a new alarm.

G. Trendlog Information

1. AWS shall periodically gather historically recorded data stored in the building controllers and store the information in the system database. Stored records shall be appended with new sample data, allowing records to be accumulated. Systems that write over stored records shall not be allowed unless limited file size is specified. System database shall be capable of storing up to 50 million records before needing to archive data. Samples may be viewed at the web client. All trendlog records shall be displayed in standard engineering units.

2. AWS shall be capable of trending on an interval determined by a polling rate, or change-of-value.

3. AWS, Thick client, or Web Client shall be able to add and edit trendlogs and the setup information. This includes the information to be logged as well as the interval at which it is to be logged. All operations shall be password protected. Viewing may be accessed directly from any and all graphics on which a trended object is displayed.

4. AWS and Thick Client shall include a Trendlog Wizard for setup of multiple trend logs simultaneously. Wizard shall walk user through all necessary steps. Wizard shall have its own pull-down selection for startup, or may be started by right-clicking on value displayed on graphic, and then selecting Trendlogs from the displayed menu.

5. AWS shall be capable of using Microsoft SQL as the system database.

6. Any displayed data that is changeable by the operator may be selected using the right mouse button and the trendlog shall then be selectable from a menu on the screen. Selection of the trendlog using this method shall allow the viewing of the trendlog data in the DataViewer.

7. DataViewer shall provide:

    a. Software that is capable of graphing the trend-logged object data shall be included.

    b. Access and ability to create, edit and view are restricted to users by user account credentials

    c. Specific and repeatable URL defines the trendlog(s) views for browser bookmarking and email compatibility.

    d. Call out of trendlog value at intersection of trend line and mouse-over vertical axis.

    e. Trendlog or Energy log and companion logs can be configured to display on one of two independent vertical scales embedded in the display.

    f. Click zoom for control of data set viewed along either graph axis.

    g. User-specifiable start and end dates as well as a fast scroll features that supports click zoom of macro scale view of the data for quickly finding data set based on visual signature.

    h. User export of the viewed data set to MS Excel.

    i. Web browser-based help.

    j. Optional min/max ranges (Upper Control Limits, Lower Control Limits) for each value.

H. Energy Log Information

1. AWS shall be capable of periodically gathering energy log data stored in the field equipment and archive the information. Archive files shall be appended with new data, allowing data to be accumulated. Systems that write over archived data shall not be allowed unless limited file size is specified. Display all energy log information in standard engineering units.

2. All data shall be stored in database file format for direct use by third-party programs. Operation of system shall stay completely online during all graphing operations.

3. AWS operator shall be able to change the energy log setup information as well. This includes the meters to be logged, meter pulse value, and the type of energy units to be logged. All meters monitored by the system may be logged. System shall support using flow and temperature sensors for BTU monitoring.

4. AWS shall display data in tabular format form for both consumption and peak values. Data shall be shown in hourly, daily, weekly, monthly and yearly formats. In each format, the user shall be able to select a specific period of data to view.

5. Web client shall display data in tabular format and graphical format. Data shall be shown in hourly, daily, weekly, monthly and yearly formats. In each format, the user shall be able to select a specific period of data to view.

I. Demand Limiting

1. AWS shall include demand limiting program that includes two types of load shedding. One type of load shedding shall shed/restore equipment in binary fashion based on energy usage when compared to shed and restore settings. The other type of shedding shall adjust operator-selected control setpoints in an analog fashion based on energy usage when compared to shed and restore settings. Shedding may be implemented independently on each and every zone or a single piece of equipment connected to system.

2. Binary shedding shall include minimum of five (5) priority levels of equipment shedding. All loads in a given priority level shall be shed before any loads in a higher priority level are shed. Load shedding within a given priority level shall include two methods. In one, the loads shall be shed/restored in a “first off-first on” mode, and in the other the loads are just shed/restored in a “first off-last on” (linear) fashion.

3. Analog shed program shall generate a ramp that is independently used by each individual zone or individual control algorithm to raise the appropriate cooling setting and lower appropriate heating setting to reduce energy usage.

4. AWS shall be able to display the status of each and every load shed program. Status of each load assigned to an individual shed program shall be displayed along with English description of each load.

J. Reports

1. AWS shall be capable of periodically producing reports of trendlogs, alarm history, tenant activities, device summary, energy logs, and override points. The frequency, content, and delivery are to be user adjustable.

2. All reports shall be capable of being delivered in multiple formats including text- and comma-separated value (CSV) files. The files can be printed, emailed, or saved to a folder, either on the server hard drive or on any network drive location.

K. Field Engineering Tools

1. AWS shall include field engineering tools for programming all controllers supplied. All controllers shall be programmed using graphical tools that allow the user to connect function blocks on screen that provide sequencing of all control logic. Function blocks shall be represented by graphical displays that are easily identified and distinct from other types of blocks. Graphical programming that uses simple rectangles and squares is not acceptable.

2. User shall be able to select a graphical function block from menu and place on screen. Provide zoom in and zoom out capabilities. Function blocks shall be downloaded to controller without any reentry of data.

3. Programming tools shall include a real-time operation mode. Function blocks shall display real-time data and be animated to show status of data inputs and outputs when in real-time operation. Animation shall show change of status on logic devices and countdown of timer devices in graphical format.

4. Field engineering tools shall also include a database manager of applications that include logic files for controllers and associated graphics. Operator shall be able to select unit type, input/output configuration and other items that define unit to be controlled. Supply minimum of 250 applications as part of workstation software.

5. Field engineering tool shall include Device Manager for detection of devices connected

anywhere on the BACnet network by scanning the entire network. This function shall display device instance, network identification, model number, and description of connected devices. It shall record and display software file loaded into each controller. A copy of each file shall be stored on the computer's hard drive. If needed, this file shall be downloaded to the appropriate controller using the mouse.

6. AWS shall automatically notify the user when a device that is not in the database is added to the network.

7. AWS shall include backup/restore function that will back up entire system to selected medium and then restore system from that medium. The system shall be capable of creating a backup for the purpose of instantiating a new client PC.

8. The system shall provide a means to scan, detect, interrogate, and edit third-party BACnet devices and BACnet objects within those devices.

L. Software

1. At the conclusion of the project, contractor shall leave with owner a electronic copy that includes the complete software operation system and project graphics, setpoints, system parameters, etc. This backup shall allow the owner to completely restore the system in the case of a computer malfunction.

2.2 BUILDING CONTROLLER

A. General Requirements

1. BACnet Conformance

a. Building Controller shall be approved by the BTL as meeting the BACnet Building Controller requirements.

b. Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

2. Building controller shall be of scalable design such that the number of trunks and protocols may be selected to fit the specific requirements of a given project.

3. The controller shall be capable of panel-mounted on DIN rail and/or mounting screws.

4. The controller shall be capable of providing global control strategies for the system based on information from any objects in the system, regardless if the object is directly monitored by the building controller module or by another controller.

5. The controller shall be capable of running up to six (6) independent control strategies simultaneously. The modification of one control strategy does not interrupt the function or runtime others.

6. The software program implementing the DDC strategies shall be completely flexible and user-definable. All software tools necessary for programming shall be provided as part of project software. Any systems utilizing factory pre-programmed global strategies that cannot be modified by field personnel on-site, using a wide area network (WAN) or downloaded through remote communications are not acceptable. Changing global strategies using firmware changes is also unacceptable.

7. Programming shall be object-oriented using control function blocks and support DDC functions. All flowcharts shall be generated and automatically downloaded to controller. Programming tool shall be supplied and be resident on workstation. The same tool shall be used for all controllers.

8. The programming tool shall provide means to graphically view inputs and outputs to each program block in real-time as program is executing. This function may be performed using the operator's workstation or field computer.

9. Controller shall have 6,000 Analog Values and 6,000 Binary Values.

10. Controller IP configuration can be done via a direct USB connect with an operator's workstation or field computer.

11. Controller shall have at a minimum a Quad Core 996Ghz processor to ensure fast processing speeds.

12. Global control algorithms and automated control functions shall execute using a 64-bit processor.

13. Controller shall have a minimum of 1 GB of DDR3 SDRAM on a 533Mhz bus to ensure high speed data recording, large data storage capacity and reliability.

14. Controller shall support two (2) on-board EIA-485 ports capable of supporting various EIA-485 protocols including, but not limited to BACnet MS/TP and Modbus.

    a. Ports are capable of supporting various EIA-485 protocols including, but not limited to BACnet MS/TP and Modbus.

15. Controller shall support two (2) ports—each of gigabit speed—Ethernet (10/100/1000) ports.

    a. Ports are capable of supporting various Ethernet protocols including, but not limited to BACnet IP, FOX, and Modbus.

16. All ports shall be capable of having protocol(s) assigned to utilize the port's physical connection.

18. Schedules

    a. Building controller modules shall provide normal seven-day scheduling, holiday scheduling and event scheduling.

    b. Each building controller shall support a minimum of 380 BACnet Schedule Objects and 380 BACnet Calendar Objects.

19. Logging Capabilities

    a. Each building controller shall log as minimum 2,000 objects at 15-minute intervals. Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.

    b. Logs may be viewed both on-site or off-site using WAN or remote communication.

    c. Building controller shall periodically upload trended data to networked operator's workstation for long-term archiving if desired.

    d. Archived data stored in database format shall be available for use in third-party

spreadsheet or database programs.

20. Alarm Generation

a. Alarms may be generated within the system for any object change of value or state (either real or calculated). This includes things such as analog object value changes, binary object state changes, and various controller communication failures.

b. Each alarm may be dialed out as noted elsewhere.

c. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site using remote communications.

d. Controller must be able to handle up to 2,000 alarm setups stored as BACnet event enrollment objects, with system destination and actions individually configurable.

21. Demand Limiting

a. Demand limiting of energy shall be a built-in, user-configurable function. Each controller module shall support shedding of up to 1,200 loads using a minimum of two types of shed programs.

b. Load shedding programs in building controller modules shall operate as defined in section 2.1.I of this specification.

B. BACnet MS/TP

1. BACnet MS/TP LAN must be software-configurable from 9.6 to 115.4Kbps

a. Each BACnet MS/TP LAN shall support 64 BACnet devices at a minimum.

b. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. BACnet IP

1. The building controller shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the local area network (LAN).

2. Must support interoperability on WANs and campus area networks (CANs), and function as a BACnet Broadcast Management Device (BBMD).

3. Each controller shall support at a minimum 128 BBMD entries.

4. BBMD management architecture shall support 3,000 subnets at a minimum.

5. Shall support BACnet Network Address Translation.

6. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

D. Expansion Ports

1. Controller shall support two (2) expansion ports.

a. Combining the two on-board EIA-458 ports with fully loaded expansion ports, the controller shall support six (6) EIA-485 trunks simultaneously.

F. Power Supply

1. Input for power shall accept between 17 and 30VAC, 47 and 63Hz.

2. Optional rechargeable battery for shutdown of controller including storage of all data in flash memory.

3. On-board capacitor will ensure continuous operation of real-time clocks for minimum of 14 days.

G. Controller shall be in compliance with the following:

1. UL 916 for open energy management

2. FCC Class B

3. ROHS

4. IEC 60703

5. C-Tick Listed

H. Controller shall operate in the following environmental conditions:

1. -4 to 149 °F without optional battery, or 32 to 122 °F with optional battery.

2. 0 to 95% relative humidity (RH), non-condensing.

2.3 CENTRAL PLANT AND AIR HANDLER APPLICATION CONTROLLERS

A. Provide one or more native BACnet application controllers for each air handler and provide native BACnet application controllers as needed for central plant control that adequately cover all objects listed in object list. All controllers shall interface to building controller through either MS/TP LAN using BACnet protocol, or Ethernet LAN using BACnet over Ethernet or BACnet TCP/IP. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of units. Controllers shall be fully programmable using graphical programming blocks. Programming tool shall be resident on operator workstation and be the same tool as used for the building controller. No auxiliary or non-BACnet controllers shall be used.

B. BACnet Conformance

1. Application controllers shall be approved by the BTL as meeting the BACnet Advanced Application Controller requirements.

2. Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

3. Standard BACnet object types supported shall include, as a minimum, Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Multi-state Values, Device, File, and Program object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. Application controllers shall include universal inputs with 12-bit resolution that accept 3K and 10K thermistors, 0–10VDC, Platinum 1000 ohm RTD, 0–5VDC, 4–20mA and dry contact signals. Any input on a controller may be either analog or digital with a minimum of three inputs that accept pulses. Controller shall also include support and modifiable programming for interface to intelligent room sensor with digital display. Controller shall include binary and analog outputs on board. Analog outputs with 12-bit resolution shall support either 0–10VDC or 0–20mA. Binary outputs shall have LED indication of status. Software shall include scaling features for analog outputs. Application controller shall include 20VDC voltage supply for use as power supply to external sensors.

1. All outputs must have onboard Hand-Off-Auto (HOA) switches and a status indicator light. HOA switch position shall be monitored. Each analog output shall include a potentiometer for manually adjusting the output when the HOA switch is in the Hand position.

2. The position of each and every HOA switch shall be available system wide as a BACnet object property.

D. All program sequences shall be stored on board application controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller up to 20 times per second (minimum of 10 times per second) and capable of multiple PID loops for control of multiple devices. All calculations shall be completed using floating-point math and system shall support display of all information in floating-point nomenclature at operator's terminal.

1. The following control blocks shall be supported:

    a. Natural Log

    b. Exponential

    c. Log base 10

    d. X to the power of Y

    e. Nth square root of X

    f. 5th Order Polynomial Equations

    g. Astronomical Clock (sunrise/sunset calculation)

    h. Time based schedules

E. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely using modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using programming tools as described in operator's terminal section.

F. Application controller shall include support for intelligent room sensor (see Section 2.10.B.) Display on intelligent room sensor shall be programmable at application controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode, based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

G. Schedules

1. The controller shall support a minimum of 3 BACnet Schedule Objects and have a real time

clock on board with battery backup to maintain time through a power loss.

H. Logging Capabilities

1. Controller shall support a minimum of 50 trendlogs. Any object in the controller (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.

2. Controller shall periodically upload trended data to system server for long-term archiving if desired. Archived data stored in (MS Jet Database or SQL) database form and shall be available for use in third-party spreadsheet or database programs.

I. Alarm Generation

1. Alarms may be generated within the controller for any object change of value or state (either real or calculated). This includes things such as analog object value changes, and binary object state changes.

2. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site using remote communications.

3. Controller must be able to handle up to 25 alarm setups stored as BACnet event enrollment objects, with system destination and actions individually configurable.

J. The controller processor shall be a 32-bit processor.

K. The packaging of the controller shall provide operable doors to cover the terminals once installation is complete. The housing of the controller shall provide for DIN rail mounting and also fully enclose circuit board.

2.4 TERMINAL UNIT APPLICATION CONTROLLERS (Heat Pumps, AC Units, Fan-Coils)

A. Provide one native BACnet application controller for each piece of unitary mechanical equipment that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller through MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of unit.

B. BACnet Conformance

1. Application controllers shall, as a minimum, support MS/TP BACnet LAN types. They shall communicate directly using this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps, as a native BACnet device. Application controllers shall be approved by the BTL as meeting the BACnet Application Specific Controller requirements and support all BACnet services necessary to provide the following BACnet functional groups:

a. Files Functional Group

b. Reinitialize Functional Group

c. Device Communications Functional Group

2. Please refer to Section 22.2, BACnet Functional Groups in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

3. Standard BACnet object types supported shall include, as a minimum, Analog Input,

Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File, and Program Object Types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. Application controllers shall include universal inputs with 10-bit resolution that can accept 3K and 10K thermistors, 0–5VDC, 4–20mA, dry contact signals and a minimum of 3 pulse inputs. Any input on controller may be either analog or digital. Controller shall also include support and modifiable programming for interface to intelligent room sensor. Controller shall include binary outputs on board with analog outputs as needed.

D. All program sequences shall be stored on board controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely through modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using same programming tools as building controller and as described in operator workstation section. All programming tools shall be provided and installed as part of system.

E. Application controller shall include support for intelligent room sensor (see Section 2.10.B.) Display on room sensor shall be programmable at controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

2.5 VAV BOX CONTROLLERS—SINGLE DUCT

A. Provide one native BACnet application controller for each VAV box that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller through MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include on board CFM flow sensor, inputs, outputs and programmable, self-contained logic program as needed for control of units.

B. BACnet Conformance

1. Application controllers shall, at a minimum, support MS/TP BACnet LAN types. They shall communicate directly through this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps, as a native BACnet device. Application controllers shall be approved by the BTL as meeting the BACnet Application Specific Controller requirements.

2. Please refer to Section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

3. Standard BACnet object types supported shall include, as a minimum, Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File, and Program Object Types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

C. Application controllers shall include universal inputs with 10-bit resolution that can accept 3K and 10K thermistors, 0–5 VDC, and dry contact signals. Inputs on controller may be either analog or digital. Controller shall also include support and modifiable programming for interface to intelligent room sensor with digital display. Controller shall also include binary outputs on

board. For applications using variable speed parallel fans, provide a single analog output selectable for 0-10 V or 0-20 mA control signals. Application controller shall include microprocessor driven flow sensor for use in pressure independent control logic. All boxes shall be controlled using pressure-independent control algorithms and all flow readings shall be in CFM (LPS if metric).

D. All program sequences shall be stored on board application controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely using modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using the same programming tool as Building Controller and as described in operator's workstation section. All programming tools shall be provided as part of system.

E. Application controller shall include support for intelligent room sensor (see Section 2.10.B.) Display on room sensor shall be programmable at application controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode based on which button is pressed on the sensor. See sequence of operations for specific display requirements for intelligent room sensor.

F. On board flow sensor shall be microprocessor-driven and pre-calibrated at the factory. Pre-calibration shall be at 16 flow points as a minimum. All factory calibration data shall be stored in non-volatile memory. Calibration data shall be field adjustable to compensate for variations in VAV box type and installation. All calibration parameters shall be adjustable through intelligent room sensor. Operator's workstation, portable computers, and special hand-held field tools shall not be needed for field calibration.

G. Provide duct temperature sensor at discharge of each VAV box that is connected to controller for reporting back to operator's workstation.

2.6 AUXILIARY CONTROL DEVICES

A. Temperature Sensors

1. Provide the following instrumentation as required by the monitoring, control and optimization functions. All temperature sensors shall use Thermistor or platinum RTD elements. All temperature sensors to be solid-state electronic, interchangeable with housing appropriate for application. Wall sensors to be installed as indicated on drawings. Duct sensors to be installed such that the sensing element is in the main air stream. Immersion sensors to be installed in wells provided by control contractor, but installed by mechanical contractor. Immersion wells shall be filled with thermal compound before installation of immersion sensors. Outside air sensors shall be installed away from exhaust or relief vents, not in an outside air intake, and in a location, that is in the shade most of the day. All Temperature Sensors shall be Alerton, ACI or Veris.

a. Room Temperature:

- Sensor Output: 10KΩ @ 77°F
- Sensor Accuracy: ±0.36°F from 32 to 158°F
- Operating Temperature Range: -40 to 212°F
- Operating Humidity Range: 0 to 90% RH non-condensing

b. Liquid Immersion Temperature:

- Sensor Output: 10KΩ @ 77°F
- Sensor Accuracy: ±0.36°F from 32 to 158°F
- Operating Temperature Range: -40 to 302°F
- Operating Humidity Range: 10 to 95% RH non-condensing

c. Duct (Single Point & Averaging) Temperature

- Sensor Output: 10KΩ @ 77°F
- Sensor Accuracy: ±0.36°F from 32 to 158°F
- Operating Temperature Range: -40 to 302°F
- Operating Humidity Range: 10 to 95% RH non-condensing

d. Outside Air Temperature

- Sensor Output: 10KΩ @ 77°F
- Sensor Accuracy: ±0.36°F from 32 to 158°F
- Operating Temperature Range: -40 to 302°F
- Operating Humidity Range: 10 to 95% RH non-condensing

B. Humidity Sensor

1. Provide the following instrumentation as required by the monitoring, control and optimization functions. All humidity sensors shall be transmitters. Sensor output shall be 0-10V or 4-20mA signal. Sensor shall operate from 24 VDC or 24 VAC power source. The sensors shall be wall or duct mounted type as indicated on plans and in the sequence of operation. Wall sensors to be installed as indicated on drawings. Duct sensors to be installed such that the sensing element is in the main air stream. Outside air sensors shall be installed away from exhaust or relief vents, not in an outside air intake, and in a location, that is in the shade most of the day. All humidity sensors shall be Alerton or ACI.

a. Outdoor/Duct Humidity Sensor

- Sensor Output: 4-20mA or 0-10 VDC
- Sensor Accuracy: ±2% from 10 to 95% RH
- Operating Temperature Range: -40 to 140°F
- Operating Humidity Range: 0 to 100% RH
- Long Term Stability: 2% drift/5 years

b. Room Humidity Sensor

- Sensor Output: 4-20mA or 0-10 VDC

- Sensor Accuracy: ±2% from 10 to 95% RH
- Operating Temperature Range: -40 to 140°F
- Operating Humidity Range: 0 to 100% RH
- Long Term Stability: 2% drift/5 years

C. Indoor Air Quality (CO2) sensor

1. Provide the following instrumentation as required by the monitoring, control and optimization functions. The sensor shall be compliant with ASHRAE 62.1 standard. The sensors shall be a non-dispersive infrared (NDIR) operation. Sensor shall have field selectable outputs of 0-10V or 4-20mA. Sensor shall operate from 24 VDC or 24 VAC power source. The sensors shall be wall or duct mounted type as indicated on plans and in the sequence of operation. Wall sensors to be installed as indicated on drawings. Mount 48 inches above finished floor. Duct sensors to be installed such that the sensing element is in the main air stream. All CO2 sensors shall be Alerton, ACI or Veris.

    a. Wall Mounted

        - Sensor Range: 0-2000ppm
        - Sensor Accuracy: ±30ppm ±5% of measured value
        - Sensor Repeatability: ±20ppm ±1% of measured value
        - Operating Temperature Range: 32 to 122°F
        - Operating Humidity Range: 0 to 95% RH
        - 5-year calibration interval

    b. Duct Mounted

        - Sensor Range: 0-2000ppm or 0-5000ppm
        - Sensor Accuracy: ±30ppm ±5% of measured value
        - Sensor Repeatability: ±20ppm ±1% of measured value
        - Operating Temperature Range: 32 to 122°F
        - Operating Humidity Range: 0 to 95% RH
        - 5-year calibration interval

D. Differential Pressure Transmitters

1. Provide the following instrumentation as required by the monitoring, control and optimization functions. Pressure range to suit application. Sensor shall have provision for zeroing by pushbutton or digital input. Sensor shall have field selectable outputs of 0-5V, 0-10V, and 4-20mA. Sensor shall operate from 24 VDC or 24 VAC power source. Sensor shall be switch or jumper selectable for pressure ranges and for flow direction (uni-directional or bi-directional). All pressure sensors shall be Alerton, ACI or Veris.

a. Fluid Pressure Transmitter

- Sensor Pressure Range: 0-100 PSI, as needed
- Sensor Accuracy: ±2.0% FSO (includes linearity, hysteresis and repeatability.)
- Operating Temperature Range: -22 to 248°F
- Operating Humidity Range: 10 to 90% RH
- Enclosure rating: NEMA 4

b. Dry Media Pressure Transmitter

- Sensor Pressure Range: -5.0” W.C. to 5.0” W.C., as needed
- Sensor Accuracy: ±2.0% FSO (includes linearity, hysteresis and repeatability.)
- Operating Temperature Range: 32 to 140°F
- Operating Humidity Range: 0 to 95% RH

E. Control Relays

1. Control relays shall be UL listed plug-in type with dust cover and LED “energized” indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
2. Acceptable Manufacturers are IDEC, Functional Devices or Veris.

F. Current Sensors

1. Current sensor shall be self-powered and solid state. The switches shall be selected to match the current of the application and output requirements of the DDC system. The current shall provide visual indication (LED) for output status and sensor. Current sensor shall be Alerton, ACI or Veris.

G. Intelligent Room Sensor with Touchscreen

1. Hardware
   a. Room sensor shall include:
      i. Backlit touchscreen LCD digital display
      ii. Temperature sensor
      iii. Humidity sensor
      iv. Programmable Status Light indicator
      v. CO2 sensor or BACnet MS/TP communication up to 115.2kbps
   b. Temperature sensor shall be a Uni-Curve Type II thermistor with an accuracy of +/- 0.36 °F (0.3 °C) at calibration point over the range of 32 to 158 °F or better.

c. Humidity sensor shall have an accuracy of +/-3% from 10 to 90% relative humidity (RH) or better, non-condensing.

d. The intelligent room sensor's Status Light indicator shall have a minimum of four (4) colors (blue, red, amber and green) that will cast a glow onto the wall below the sensor to be used as visual indicator to the occupants of the condition of the system. The color and on/off state of the Status Light indicator shall be fully programmable.

e. CO2 sensor shall have an accuracy of +/- 30 ppm over the range of 0–5000 ppm or better.

f. CO2 sensor shall utilize Automatic Baseline Correction to maintain sensor calibration without the need for manual calibration.

g. The user shall interact with the smart sensor using a touchscreen, with no buttons allowed.

h. The intelligent room sensor shall have provisions for a tamper proof installation requiring tools to be removed from the wall.

i. The touchscreen shall have a surface hardness of Mohs 7 or greater to prevent being easily scratched.

j. Controller shall function as room control unit, and allow occupant to raise and lower setpoint, and activate terminal unit for override use—all within limits as programmed by building operator.

2. Display Content

a. The intelligent room sensor shall simultaneously display room setpoint, room temperature, and outside temperature at each controller.

b. The intelligent room sensor shall have the ability to add or remove from the display time-of-day, room humidity, and indoor air temperature to customize the view for the customer.

c. The intelligent room sensor must have the capability to show temperatures in degrees Fahrenheit or degrees Celsius.

d. A communication loss or improper communications wiring shall be displayed on the LCD screen to aid in trouble shooting.

e. Information about the version of firmware shall be displayable on the LCD screen.

f. A cleaning mode will be provided to allow for the touchscreen to be cleaned without inadvertently making changes to system parameters.

g. The intelligent room sensor shall have the ability to display the status of a lighting zone and control the on/off state of the zone from the touchscreen using a tenant-accessible display page.

h. The intelligent room sensor shall have the ability to display the status of a window zone (e.g., blinds) and control the on/off state of the zone from the touchscreen using a tenant-accessible display page.

i. After Hours Override shall:

vi. Override time may be set and viewed in 30-minute increments.

vii. Override time countdown shall be automatic, but may be reset to zero by occupant from the sensor.

viii. Time remaining shall be displayed.

ix. Display shall show the word “OFF” in unoccupied mode unless a function button is pressed.

3. Other Modes

a. The intelligent room sensor shall also allow service technician access to hidden functions for advanced system configuration. This functionality shall be accessed-protected with a configurable PIN number.

b. Field Service Mode shall allow access to common parameters as dictated by the application’s sequence of operations. The parameters shall be viewed and set from the intelligent room sensor with no computer or other field service tool needed.

c. If the intelligent room sensor is connected to VAV controller, Balance Mode shall allow a VAV box to be balanced and all air flow parameters viewed. The balancing parameters shall be viewed and set from the intelligent room sensor with no computer or other field service tool needed.

4. Intelligent Room Sensor shall be in compliance of the following:

a. UL Standard for Safety 916

b. FCC Part 15.107 & 109, Class B, CFR47-15

c. EMC Directive 89/336/EEC (European CE Mark)

2.7 ELECTRONIC ACTUATORS AND VALVES

A. Quality Assurance for Actuators and Valves

1. UL Listed Standard 873 and C.S.A. Class 4813 02 certified.

2. NEMA 2 rated enclosures for inside mounting, provide with weather shield for outside mounting.

3. Five-year manufacturer’s warranty. Two-year unconditional and three-year product defect from date of installation.

B. Execution Details for Actuators and Valves

1. Furnish a Freeze-stat and install “Hard Wire” interlock to disconnect the mechanical spring return actuator power circuit for fail-safe operation. Use of the control signal to drive the actuators closed is not acceptable.

2. Each DDC analog output point shall have an actuator feedback signal, independent of control signal, wired and terminated in the control panel for true position information and troubleshooting. Or the actuator feedback signal may be wired to the DDC as an analog input for true actuator position status.

3. VAV box damper actuation shall be floating type or analog (2–10VDC, 4–20mA).

4. Booster-heat valve actuation shall be floating type or analog (2-10vdc, 4-20ma).

5. Primary valve control shall be analog (2–10VDC, 4–20mA).

C. Actuators for damper and control valves 0.5–6 inches shall be electric unless otherwise specified, provide actuators as follows:

1. UL Listed Standard 873 and Canadian Standards association Class 481302 shall certify actuators.

2. NEMA 2 rated actuator enclosures for inside mounting. Use additional weather shield to protect actuator when mounted outside.

3. Five-year manufacturer's warranty. Two-year unconditional and Three year product defect from date of installation.

4. Mechanical spring shall be provided when specified. Capacitors or other non-mechanical forms of fail-safe are not acceptable.

5. Position indicator device shall be installed and made visible to the exposed side of the actuator. For damper short shaft mounting, a separate indicator shall be provided to the exposed side of the actuator.

6. Overload Protection: Actuators shall provide protection against actuator burnout by using an internal current limiting circuit or digital motor rotation sensing circuit. Circuit shall insure that actuators cannot burn out due to stalled damper or mechanical and electrical paralleling. End switches to deactivate the actuator at the end of rotation are acceptable only for butterfly valve actuators.

7. A Pushbutton gearbox release shall be provided for all non-spring actuators.

8. Modulating actuators shall be 24VAC and consume 10VA power or less.

9. Conduit connectors are required when specified and when code requires it.

D. Damper Actuators:

1. Outside air and exhaust air damper actuators shall be mechanical spring return. Capacitors or other non-mechanical forms of fail-safe are not acceptable. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the damper as required.

2. Economizer actuators shall utilize analog control 2–10VDC, floating control is not acceptable.

3. Electric damper actuators (including VAV box actuators) shall be direct shaft-mounted and use a V-bolt and toothed V-clamp causing a cold weld effect for positive gripping. Single bolt or set-screw type fasteners are not acceptable.

4. One electronic actuator shall be direct shaft-mounted per damper section. No connecting rods or jackshafts shall be needed. Small outside air and return air economizer dampers may be mechanically linked together if one actuator has sufficient torque to drive both and damper drive shafts are both horizontal installed.

5. Multi-section dampers with electric actuators shall be arranged so that each damper section operates individually. One electronic actuator shall be direct shaft-mounted per damper section. (See below execution section for more installation details.)

E. Valve Actuators 0.5–6 inches

1. Mechanical spring shall be provided on all actuators for pre-heat coil and actuators for AHU heating or cooling coil when units are mounted outside. See plans for fail-safe flow function: Normal Open or Normal Closed. Capacitors or other non-mechanical forms of fail-safe are not acceptable.

2. All zone service actuators shall be non-spring return unless otherwise specified.

3. The valve actuator shall be capable of providing the minimum torque required for proper valve close-off for the required application.

4. All control valves actuators shall have an attached 3-foot cable for easy installation to a junction box.

5. Override handle and gearbox release shall be provided for all non-spring return valve actuators.

F. Control Dampers.

1. The BAS contractor or sheet metal contractor shall furnish and size all automatic control dampers unless provided with packaged equipment. The sheet metal contractor shall install all dampers unless provided with packaged equipment.

2. All dampers used for modulating service shall be opposed blade type and arranged for normally open or normally closed operation as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop for effective throttling.

3. All dampers used for two-position or open-close control shall be parallel blade type arranged for normally open or closed operation as required.

4. Damper linkage hardware shall be constructed of aluminum or corrosion-resistant zinc and nickel-plated steel and furnished as follows:

5. Bearing support bracket and drive blade pin extension shall be provided for each damper section. Sheet metal contractor shall install bearing support bracket and drive blade pin extension. Sheet metal contractor shall provide permanent indication of blade position by scratching or marking the visible end of the drive blade pin extension.

6. Drive pin may be round only if V-bolt and toothed V-clamp is used to cause a cold weld effect for positive gripping. For single bolt or set-screw type actuator fasteners, round damper pin shafts must be milled with at least one side flat to avoid slippage.

7. Damper manufacturer shall supply alignment plates for all multi-section dampers.

G. Control Valves 0.5–6 inches

1. The BAS contractor shall furnish all specified motorized control valves and actuators. BAS contractor shall furnish all control wiring to actuators. The plumbing contractor shall install all valves. Equal percentage control characteristic shall be provided for all water coil control valves. Linear valve characteristic is acceptable for 3-way valves that are 2.5 inches and above.

2. Characterized control valves shall be used for hydronic heating or cooling applications and small to medium AHU water-coil applications to 100GPM. Actuators are non-spring return for terminal unit coil control unless otherwise noted. If the coil is exposed to the outside air stream, see plans for spring return requirement.

a. Leakage is zero percent, close-off is 200psi, maximum differential is 30psi; rangeability is 500:1.

b. Valves 0.5–2 inches shall be nickel-plated forged brass body, NPT screw type connections.

c. Valves 0.5–1.25 inches shall be rated for ANSI Class 600 working pressure. Valves 1.5 and 2 inches shall be rated for ANSI Class 400 working pressure.

d. The operating temperature range shall be 0–250 degrees F.

e. Stainless steel ball and stem shall be furnished on all modulating valves.

f. Seats shall be fiberglass reinforced Teflon.

g. Two-way and three-way valves shall have an equal percentage control port. Full stem rotation is required for maximum flow to insure stable BTU control of the coil.

h. Three-way valve shall be applicable for both mixing and diverting.

i. The characterizing disc is made of TEFZEL and shall be keyed and held secure by a retaining ring.

j. The valves shall have a blow-out proof stem design.

k. The stem packing shall consist of 2 lubricated O-rings designed for on-off or modulating service and require no maintenance.

l. The valves shall have an ISO type, 4-bolt flange for mounting actuator in any orientation parallel or perpendicular to the pipe.

m. A non-metallic thermal isolation adapter shall separate valve flange from actuator.

n. One fastening screw shall secure the direct coupling of the thermal isolation adapter between the actuator and the valve. This will prevent all lateral or rotational forces from affecting the stem and its packing O-rings.

3. Globe valves 0.5–2 inches shall be used for steam control or water flow applications.

a. Valves shall be bronze body, NPT screw type, and shall be rated for ANSI Class 250 working pressure.

b. Valves 0.5 inches (DN15) through 2 inches (DN50) with spring return actuators shall close off against 50 psi pressure differential with Class III leakage (0.1%).

c. The operating temperature range shall be 20–280 degrees F.

d. Spring loaded TFE packing shall protect against leakage at the stem.

e. Two-way valves shall have an equal percentage control port.

f. Three-way valves shall have a linear control and bypass port.

g. Mixing and diverting valves must be installed specific to the valve design.

4. Globe Valve 2.5–6 inches

a. Valves 2.5 inches (DN65) through 6 inches (DN50) shall be iron body, 125 lb. flanged with Class III (0.1%) close-off leakage at 50 psi differential.

b. Valves with spring return actuators shall close off against 50 psi pressure differential with Class III leakage (0.1%).

c. Flow type for two-way valves shall be equal percentage. Flow type for three-way valves shall be linear.

d. Mixing and diverting valves must be installed specific to the valve design.

H. Butterfly valves

1. Butterfly valves shall be sized for modulating service at 60–70 degree stem rotation. Isolation valves shall be line-size. Design velocity shall be less than 12 feet per second when used with standard EPDM seats.

a. Body is cast iron.

b. Disc is aluminum bronze standard.

c. Seat is EPDM standard.

d. Body Pressure is 200 psi, -30–275 degrees F.

e. Flange is ANSI 125/250.

f. Media Temperature Range is -22–240 degree F.

g. Maximum Differential Pressure is 200 psi for 2- to 6- inch size.

I. Butterfly Valve Industrial Actuators

1. Actuators shall be approved under Canadian Standards Association or other Nationally Recognized Testing Laboratory to UL standards. CSA Class 4813 02 or equal. Enclosure shall be NEMA 4 (weatherproof) enclosure and will have an industrial quality coating.

a. Actuator shall have a motor rated for continuous duty. The motor shall be fractional horsepower; permanent split capacitor type designed to operate on a 120VAC, 1pH, 60Hz supply. Two adjustable cam-actuated end travel limit switches shall be provided to control direction of travel. A self-resetting thermal switch shall be imbedded in the motor for overload protection.

b. Reduction gearing shall be designed to withstand the actual motor stall torque. Gears shall be hardened alloy steel, permanently lubricated. A self-locking gear assembly or a brake shall be supplied.

c. Actuator shall have a 6 ft wiring harness provided for ease in field wiring (above 1500 in-lbs). Two adjustable SPDT cam-actuated auxiliary switches, rated at 250VAC shall be provided for indication of open and closed position. Actuator shall have heater and thermostat to minimize condensation within the actuator housing.

d. Actuator shall be equipped with a hand wheel for manual override to permit operation of the valve in the event of electrical power failure or system malfunction. Hand wheel must be permanently attached to the actuator and when in manual operation electrical power to the actuator will be permanently interrupted. The hand wheel will not rotate while the actuator is electrically driven.

e. The actuator shall be analog, floating, or two position as called out in the control sequence of operation. All Analog valves shall be positive positioning, and respond to

a 2–10VDC, 4-20mA, or adjustable signal as required. Analog actuators shall have a digital control card allowing any voltage input for control and any DC voltage feedback signal for position indication.

2. Performance Verification Test

   a. Control loops shall cause productive actuation with each movement of the actuator and actuators shall modulate at a rate that is stable and responsive. Actuator movement shall not occur before the effects of previous movement have affected the sensor.

   b. Actuator shall have capability of signaling a trouble alarm when the actuator Stop-Go Ratio exceeds 30%.

3. Actuator mounting for damper and valve arrangements shall comply to the following:

   a. Damper actuators: Shall not be installed in the air stream

   b. A weather shield shall be used if actuators are located outside. For damper actuators, use clear plastic enclosure.

   c. Damper or valve actuator ambient temperature shall not exceed 122 degrees F through any combination of medium temperature or surrounding air. Appropriate air gaps, thermal isolation washers or spacers, standoff legs, or insulation shall be provided as necessary.

   d. Actuator cords or conduit shall incorporate a drip leg if condensation is possible. Water shall not be allowed to contact actuator or internal parts. Location of conduits in temperatures dropping below dew point shall be avoided to prevent water from condensing in conduit and running into actuator.

   e. Damper mounting arrangements shall comply to the following:

      i. The ventilation subcontractor shall furnish and install damper channel supports and sheet metal collars.

      ii. No jack shafting of damper sections shall be allowed.

      iii. Multi-section dampers shall be arranged so that each damper section operates individually. One electronic actuator shall be direct shaft mounted per section.

   f. Size damper sections based on actuator manufacturer's specific recommendations for face velocity, differential pressure and damper type. In general:

      i. Damper section shall not exceed 24 ft-sq. with face velocity >1500 FPM.

      ii. Damper section shall not exceed 18 ft-sq. with face velocity > 2500 FPM.

      iii. Damper section shall not exceed 13 ft-sq. with face velocity > 3000 FPM.

   g. Multiple section dampers of two or more shall be arranged to allow actuators to be direct shaft mounted on the outside of the duct.

   h. Multiple section dampers of three or more sections wide shall be arranged with a 3-sided vertical channel (8 inches wide by 6 inches deep) within the duct or fan housing and between adjacent damper sections. Vertical channel shall be anchored at the top and bottom to the fan housing or building structure for support. The sides of each damper frame shall be connected to the channels. Holes in the channel shall allow damper drive blade shafts to pass through channel for direct shaft-mounting of

actuators. Open side of channel shall be faced downstream of the airflow, except for exhaust air dampers.

i. Multiple section dampers to be mounted flush within a wall or housing opening shall receive either vertical channel supports as described above or sheet metal standout collars. Sheet metal collars (12-inch minimum) shall bring each damper section out of the wall to allow direct shaft-mounting of the actuator on the side of the collar.

4. Valve Sizing for Water Coil

a. On/Off control valves shall be line size.

b. Modulating control valve body size may be reduced, at most, two pipe sizes from the line size or not less than half the pipe size. The BAS contractor shall size all water coil control valves for the application as follows:

i. Booster-heat valves shall be sized not to exceed 4–9psi differential pressure. Size valve for 50% valve authority. Valve design pressure drop is equal to the sum of coil drop plus the balance valve drop.

ii. Primary valves shall be sized not to exceed 5–15psi differential pressure. Size valve for 50% valve authority. Valve design pressure drop is equal to the sum of coil drop plus the balance valve drop.

iii. Butterfly valves shall be sized for modulating service at 60–70 degree rotation. Design velocity shall be 12 feet per second or less when used with standard EPDM seats.

c. Valve mounting arrangements shall comply to the following:

i. Unions shall be provided on all ports of two-way and three-way valves.

ii. Install three-way equal percentage characterized control valves in a mixing configuration with the “A” port piped to the coil.

iii. Install 2.5 inches and above, three-way globe valves, as manufactured for mixing or diverting service to the coil.

2.8 ENCLOSURES

A. All controllers, power supplies and relays shall be mounted in enclosures.

B. Enclosures may be NEMA 1 when located in a clean, dry, indoor environment. Indoor enclosures shall be NEMA 12 when installed in other than a clean environment.

C. Enclosures shall have hinged, locking doors.

D. Provide laminated plastic nameplates for all enclosures in any mechanical room or electrical room. Include location and unit served on nameplate. Laminated plastic shall be 0.125 inches thick and appropriately sized to make label easy to read.

2.9 AIR FLOW MEASURING STATIONS (Thermal Dispersion Type)

A. Acceptable Manufacturers
1. EBTRON, Inc.
2. Ruskin

B. Types of Mounting Application
1. Fan-Inlet

2. Duct Mounted Probe

C. Specifications:
1. Transmitter Powered by 24VAC or VDC power supply
2. Airflow Range: 0 to 10,000 FPM (fan inlet)
0 to 4,000 FPM (duct mounted)
3. Transmitter Signal Range: 0-10 VDC or 4-20mA
4. Airflow Measuring Accuracy: ±3% of measured flow
5. Temperature Reading Range -20 to 140°F
6. Temperature Reading Accuracy: ±0.15°F
7. Operating Temperature Range: -20 to 120°F
8. Operating Humidity Range: 5-95% R.H., non-condensing

2.10 LIQUID FLOW METERS

A. Insertional Turbine Flow Meters
1. Approved Manufacturers
a. ONICON

2. Provide an ONICON Model F-1210 Dual Turbine Flow Meter complete with all installation hardware necessary to enable insertion and removal of the meter without system shutdown. For bi-directional flow applications, provide ONICON Model FB-1210. The flow meter shall be hand-insertable up to 400 psi. The flow meter shall have two contra-rotating axial turbines, with electronic impedance-based sensing and an averaging circuit to reduce measurement errors due to swirl and flow profile distortion. Wetted metal components shall be nickel-plated brass (unless optional 316L SS is otherwise specified). Optional 316L SS construction is required for HW applications operating over 250 degrees F, and for any application in non-metallic pipe. The maximum operating temperature shall be 280 degrees F, 300 F peak. Each flow meter shall be individually wet-calibrated against a primary volumetric standard that is accurate to within 0.1% and traceable to NIST*. The manufacturer's certificate of calibration shall be provided with each flow meter. Accuracy shall be within ± 0.5% of rate at the calibrated velocity, within ± 1% of rate over a 10:1 turndown (3.0 to 30 ft/s) and within ± 2% of rate over a 50:1 turndown (from 0.4 to 20 ft/s). The flow meter shall include integral analog output(s), 4-20 mA, 0-10V, or 0-5V. Bi-directional meters shall include an isolated contact closure output for direction. The flow meter shall be covered by the manufacturer's two-year warranty.

B. Inline Magnetic Flow Meters
1. Approved Manufacturers
a. ONICON

2. Provide an ONICON F-3200 Series Electromagnetic Flow Meter complete with integral or remote electronics module. The electronics module shall include a backlit graphic display and keypad. Connections to the piping shall be ANSI class 150 flanges (ANSI class 300 available where required). The installing contractor is responsible for providing suitable mating flanges. The flow tube shall be epoxy coated steel; the sensing electrodes shall be 316SS; the liner shall be polypropylene or ebonite for low temperature service, PFTE for hot water service. Each flow meter shall be individually wet-calibrated and accurate to within ±0.2% of reading from 1.6 to33 feet per second velocity. A certificate of calibration shall be provided with each flow meter. Output signals shall be 4-20 mA and programmable pulse. The flow meter shall be capable of measuring bi-directional flow. For installations in non-metallic pipe, install grounding rings between flanges. Each flow meter shall be factory programmed for its specific application, and shall be re-programmable using the integral keypad on the converter (no special interface device or computer required). Each flow meter shall be covered by the manufacturer's two-year warranty.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence.

B. Notify the owner's representative in writing of conditions detrimental to the proper and timely completion of the work.

C. Do not begin work until all unsatisfactory conditions are resolved.

3.2 INSTALLATION (GENERAL)

A. Install in accordance with manufacturer's instructions.

B. Provide all miscellaneous devices, hardware, software, interconnections, installation, and programming required to ensure a complete operating system in accordance with the sequences of operation and point schedules.

3.3 LOCATION AND INSTALLATION OF COMPONENTS

A. Locate and install components for easy accessibility; in general, mount 48 inches above floor with minimum 3 feet of clear access space in front of units. Obtain approval on locations from owner's representative prior to installation.

B. All instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration, moisture, and high or low temperatures.

C. Identify all equipment and panels. Provide permanently mounted tags for all panels.

D. Provide stainless steel or brass thermowells suitable for respective application and for installation under other sections, and sized to suit pipe diameter without restricting flow.

3.4 INTERLOCKING AND CONTROL WIRING

A. Provide all interlock and control wiring. All wiring shall be installed neatly and professionally, in accordance with Specification Division 16 and all national, state and local electrical codes.

B. Provide wiring as required by functions as specified and as recommended by equipment manufacturers, to serve specified control functions. Provide shielded low capacitance wire for all communications trunks.

C. Control wiring shall not be installed in power circuit raceways. Magnetic starters and disconnect switches shall not be used as junction boxes. Provide auxiliary junction boxes as required. Coordinate location and arrangement of all control equipment with the owner's representative prior to rough-in.

D. Provide auxiliary pilot duty relays on motor starters as required for control function.

E. Provide power for all control components from nearest electrical control panel or as indicated on the electrical drawings; coordinate with electrical contractor.

F. All control wiring in the mechanical, electrical, telephone and boiler rooms to be installed in raceways. All other wiring to be installed neatly and inconspicuously per local code requirements. If local code allows, control wiring above accessible ceiling spaces may be run with plenum-rated cable (without conduit).

3.5 DDC OBJECT TYPE SUMMARY

A. Provide all database generation.

B. Displays

1. System displays shall show all analog and binary object types within the system. They shall be logically laid out for easy use by the owner. Provide outside air temperature indication on all system displays associated with economizer cycles.

C. Run Time Totalization

1. At a minimum, run time totalization shall be incorporated for each monitored supply fan, return fan, exhaust fan, hot water and chilled water pumps. Warning limits for each point shall be entered for alarm and or maintenance purposes.

D. Trendlog

1. All binary and analog object types (including zones) shall have the capability to be automatically trended.

E. Alarm

1. All analog inputs (High/Low Limits) and selected binary input alarm points shall be prioritized and routed (locally or remotely) with alarm message per owner's requirements.

F. Database Save

1. Provide backup database for all standalone application controllers on disk.

3.6 FIELD SERVICES

A. Prepare and start logic control system under provisions of this section.

B. Start up and commission systems. Allow sufficient time for startup and commissioning prior to placing control systems in permanent operation.

C. Provide the capability for off-site monitoring at control contractor's local or main office. At a minimum, off-site facility shall be capable of system diagnostics and software download. Owner shall provide phone line for this service for one year or as specified.

D. Provide owner's representative with spare parts list. Identify equipment critical to maintaining the integrity of the operating system.

3.7 AS-BUILT DOCUMENTATION REQUIRED

A. Provide final as-built control drawings to match the installed system at the time of project completion.

3.8 TRAINING

A. Provide application engineer to instruct owner in operation of systems and equipment.

B. Provide system operator’s training to include (but not be limited to) such items as the following: modification of data displays, alarm and status descriptors, requesting data, execution of commands and request of logs. Provide this training to a minimum of three persons.

C. Provide on-site training above as required, up to 8 hours as part of this contract.

3.9 DEMONSTRATION

A. Demonstrate complete operating system to owner's representative.

END OF SECTION 230923

SECTION 231113 - FACILITY FUEL-OIL PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fuel-oil pipes, tubes, and fittings.
2. Piping specialties.
3. Joining materials.
4. Specialty valves.
5. Labels and identification.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and dimensions of individual components and profiles.
2. Include rated capacities, pressure ratings, operating characteristics, electrical characteristics, settings, and furnished specialties and accessories.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control reports.

C. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-oil equipment and accessories.

1. Indicate actual installed items by marking submittals with an arrow or box.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials, from the same production run, to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.6 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and personnel in accordance with ASME Boiler and Pressure Vessel Code.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Lift and support fuel-oil storage tanks only at designated lifting or supporting points, as indicated on Shop Drawings. Do not move or lift tanks unless empty.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store PE and PE-coated pipes, tubes, and valves in manner to avoid damaging the coating and to protect from direct sunlight.

1.8 FIELD CONDITIONS

A. Interruption of Existing Fuel-Oil Service: Do not interrupt fuel-oil service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary fuel-oil supply in accordance with requirements indicated:

1. Notify Architect, Construction Manager, and Owner no fewer than two days in advance of proposed interruption of fuel-oil service.
2. Do not proceed with interruption of fuel-oil service without written permission.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of flexible, double-containment piping and related equipment that fail in materials or workmanship within specified warranty period.

1. Failures include those due to defective materials or workmanship for materials including piping, dispenser sumps, watertight sump entry boots, terminations, and other end fittings.
2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

B. Comply with ASME B31.9, "Building Services Piping," for fuel-oil piping materials, installation, testing, and inspecting.

C. Fuel-Oil Valves: Comply with UL 842 and have service mark initials "WOG" permanently marked on valve body.

D. Comply with requirements of the EPA and of state and local authorities having jurisdiction.

E. Maximum Operating-Pressure Ratings: 3 psig fuel-oil supply pressure at oil-fired appliances.

2.2 FUEL-OIL PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A234/A234M, for butt and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

    a. Material Group: 1.1.
    b. End Connections: Threaded or butt welding to match pipe.
    c. Lapped Face: Not permitted underground.
    d. Gasket Materials: Asbestos free, ASME B16.20 metallic, or ASME B16.21 nonmetallic; gaskets compatible with fuel oil.
    e. Bolts and Nuts: ASME B18.2.1, zinc alloy-plated steel.

5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

    a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

2.3 PIPING SPECIALTIES

A. Flexible Connectors - Metallic:

1. Source Limitations: Obtain flexible connectors - metallic, from single manufacturer.
2. Listed and labeled for aboveground and underground applications by an NRTL acceptable to authorities having jurisdiction.
3. Stainless steel bellows with woven, flexible, bronze or stainless steel, wire-reinforcing protective jacket.
4. Minimum Operating Pressure: 150 psig.
5. End Connections: Socket, flanged, or threaded end to match connected piping.
6. Maximum Length: 30 inches.
7. Swivel end, 50 psig maximum operating pressure.
8. Factory-furnished anode for connection to cathodic protection.

B. Strainers - Y-Pattern:

1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 60-mesh startup strainer and perforated stainless steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

C. Air Vents - Manual:

1. Body: Bronze.
2. Internal Parts: Nonferrous.

3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

2.4 JOINING MATERIALS

A. Joint Compound and Tape for Threaded Joints: Suitable for fuel oil.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

D. Bonding Adhesive for RTRP and RTRF: As recommended by piping and fitting manufacturer.

2.5 SPECIALTY VALVES

A. Pressure Relief Valves:

1. Source Limitations: Obtain pressure relief valves from single manufacturer.
2. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
3. Body: Brass, bronze, or cast steel.
4. Springs: Stainless steel, interchangeable.
5. Seat and Seal: NBR.
6. Orifice: Stainless steel, interchangeable.
7. Factory-Applied Finish: Baked enamel.
8. Maximum Inlet Pressure: 150 psig.
9. Relief Pressure Setting: 60 psig.

B. Oil Safety Valves:

1. Source Limitations: Obtains oil safety valves from single manufacturer.
2. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
3. Body: Brass, bronze, or cast steel.
4. Springs: Stainless steel.
5. Seat and Diaphragm: NBR.
6. Orifice: Stainless steel, interchangeable.
7. Factory-Applied Finish: Baked enamel.
8. Manual override port.
9. Maximum Inlet Pressure: 60 psig.
10. Maximum Outlet Pressure: 3 psig.

C. Emergency Shutoff Valves:

1. Source Limitations: Obtain emergency shutoff valves from single manufacturer.
2. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
3. Single poppet valve.

4. Body: ASTM A126, cast iron.
5. Disk: FPM.
6. Poppet Spring: Stainless steel.
7. Stem: Plated brass.
8. O-Ring: FPM.
9. Packing Nut: PTFE-coated brass.
10. Fusible link to close valve at 165 deg F.
11. Thermal relief to vent line pressure buildup due to fire.
12. Air test port.
13. Maximum Operating Pressure: 0.5 psig.

2.6 LABELS AND IDENTIFICATION

A. Detectable Warning Tape: Acid- and alkali-resistant PE-film warning tape manufactured for marking and identifying underground utilities, minimum of 6 inches wide and 4 mils thick, continuously inscribed with description of utility, with metallic core encased in a protective jacket for corrosion protection, and detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of fuel-oil piping.

B. Examine installation of fuel-burning equipment and fuel-handling and storage equipment to verify actual locations of piping connections before installing fuel-oil piping.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.3 PREPARATION

A. Close equipment shutoff valves before turning off fuel oil to premises or piping section.

B. Comply with NFPA 30 and NFPA 31 requirements for prevention of accidental ignition.

3.4 INSTALLATION OF OUTDOOR PIPING

A. Underground Fuel-Oil Piping Burial Depth:

1. Under Compacted Backfill: 18 inches below finished grade.
2. Under Asphalt 2 Inches (51 mm) Thick: 8 inches below bottom of asphalt.

3. Under 4 Inches (102 mm) of Reinforced Concrete in Areas Subject to Vehicle Traffic: 4 inches below bottom of concrete.
4. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

B. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining, to cover, seal, and protect joints.
2. Replace pipe having damaged PE coating with new pipe.

C. Install vent pipe at a minimum slope of 2 percent downward toward fuel-oil storage tank sump.

D. Assemble and install entry boots for pipe penetrations through sump sidewalls for liquidtight joints.

E. Install metal pipes and tubes, fittings, valves, and flexible connectors at piping connections to aboveground storage tanks and underground storage tanks.

F. Install fittings for changes in direction in rigid pipe.

G. Install system components with pressure rating equal to or greater than system operating pressure.

3.5 INSTALLATION OF INDOOR PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction to allow for mechanical installations.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings at a height that allows sufficient space for ceiling panel removal.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Comply with requirements for equipment specifications for roughing-in requirements.

I. Conceal pipe installations in walls, pipe spaces, or utility spaces; above ceilings; below grade or floors; and in floor channels unless indicated to be exposed to view.

J. Prohibited Locations:

1. Do not install fuel-oil piping in solid walls or partitions.

K. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

L. Connect branch piping from top or side of horizontal piping.

M. Install unions in pipes NPS 2 and smaller at final connection to each piece of equipment and elsewhere as indicated. Unions are not required on flanged devices.

N. Do not use fuel-oil piping as grounding electrode.

O. Install sleeves and sleeve seals for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Common Work Results for HVAC."

P. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230500 "Common Work Results for HVAC."

3.6 INSTALLATION OF VALVES

A. Install manual fuel-oil shutoff valves on branch connections to fuel-oil appliance.

B. Install valves in accessible locations.

C. Install oil safety valves at inlet of each oil-fired appliance.

D. Install pressure relief valves in distribution piping between the supply and return lines.

E. Install one-piece, bronze ball valve with hose end connection at low points in fuel-oil piping.

F. Install manual air vents at high points in fuel-oil piping.

3.7 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints: Construct joints in accordance with AWS D10.12/D10.12M, using qualified processes and welding operators in accordance with "Quality Assurance" Article.

1. Bevel plain ends of steel pipe.

2. Patch factory-applied protective coating as recommended in writing by manufacturer at field welds and where damage to coating occurs during construction.

E. Flanged Joints: Install gasket material, size, type, and thickness for service application. Install gasket concentrically positioned.

3.8 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for hangers, supports, and anchor devices specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Install hangers for steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Support horizontal piping within 12 inches of each fitting and coupling.

D. Support vertical runs of steel piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.9 PIPING CONNECTIONS

A. Where installing piping adjacent to equipment, allow space for service and maintenance.

B. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment having threaded pipe connection.

C. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.

D. Connect piping to equipment with shutoff valve and union. Install union between valve and equipment.

E. Install flexible piping connectors at final connection to burners, oil-fired appliances, and day tanks.

3.10 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplates and signs on or near each service regulator, service meter, and earthquake valve.

1. Text: In addition to identifying unit, distinguish between multiple units; inform operator of operational requirements; indicate safety and emergency precautions; and warn of hazards and improper operations.

B. Install detectable warning tape directly above buried fuel-oil piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs. Terminate tracer wire in an accessible area, and identify as "tracer wire" for future use with plastic-laminate sign.

1. Piping: Over underground fuel-oil distribution piping.

3.11 FIELD QUALITY CONTROL

A. Manufacturer Field Services: Engage a factory-authorized service representative to support field tests and inspections.

B. Tests and Inspections:

1. Piping Pressure Test: Minimum hydrostatic or pneumatic test-pressures measured at highest point in system.

a. Fuel-Oil Distribution Piping:

1) Hydrostatic: Minimum 150 percent of maximum anticipated pressure or 5 psig.
2) Pneumatic: Minimum 110 percent of maximum anticipated pressure.
3) Pressure to be maintained while complete visual inspection of all joints and connections is conducted.
4) In no case is test pressure to be less than a gauge pressure of 5 psi measured at the highest point of the system.
5) In no case is test pressure to be maintained for less than 10 minutes.

b. Suction Piping: Minimum 20 in. Hg for minimum 30 minutes.
c. Isolate storage tanks if test pressure in piping will cause pressure in storage tanks to exceed 10 psig.

C. Inspect and test fuel-oil piping in accordance with NFPA 31, "Tests of Piping" Paragraph; and in accordance with requirements of authorities having jurisdiction.

D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Bleed air from fuel-oil piping using manual air vents.

F. Fuel-oil piping and equipment will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.12 OUTDOOR PIPING SCHEDULE

A. Underground fuel-oil-tank fill and vent piping to be the following:

1. NPS 2 (DN 50) Pipe Size and Smaller: Steel pipe, steel or malleable-iron threaded fittings, and threaded joints. Coat pipe and fittings with protective coating for steel piping.
2. NPS 2-1/2 (DN 65) Pipe Size and Larger: Steel pipe, steel welding fittings, and welded joints. Coat pipe and fittings with protective coating for steel piping.

B. Aboveground fuel-oil piping to be the following:

1. NPS 2 (DN 50) Pipe Size and Smaller: Steel pipe, steel or malleable-iron threaded fittings, and threaded joints.
2. NPS 2-1/2 (DN 65) Pipe Size and Larger: Steel pipe, steel welding fittings, and welded joints.

3.13 INDOOR PIPING SCHEDULE

A. Aboveground fuel-oil piping to be the following:

1. NPS 1/2 (DN 15) Pipe Size and Smaller: Steel pipe with threaded joints.
2. NPS 5/8 to NPS 2 (DN 18 to DN 50): Steel pipe, steel or malleable-iron threaded fittings, and threaded joints.

3.14 SHUTOFF VALVE SCHEDULE

1. Two-piece, full-port, bronze ball valves with bronze trim.

B. Distribution piping valves for pipe NPS 2-1/2 (DN 65) and larger to be the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.

C. Valves in branch piping for single appliance to be the following:

1. One-piece, bronze ball valve with bronze trim.

END OF SECTION 231113

SECTION 231213 - FACILITY FUEL-OIL PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Submersible fuel-oil storage tank pumps.

1.2 ACTION SUBMITTALS

A. Product data.

B. Shop Drawings: For fuel-oil pumps.

1. Include construction details and dimensions of individual components for fuel-oil pumps.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Scale: 1/4 inch per foot.

C. Delegated Design Submittals: For vibration isolation indicated to comply with performance requirements and design criteria, including analysis data.

1. Detail fabrication and assembly of anchors.
2. Design Calculations: Calculate requirements for selecting seismic restraints.
3. Detail fabrication and assembly of hangers, supports, and attachments of the same to building structure.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranties: For fuel-oil pumps.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-oil pumps.

1.5 QUALITY ASSURANCE

A. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in North Carolina where Project is located and who is experienced in providing engineering services of the type indicated.

1.6 WARRANTY

A. Manufacturer Warranty: Manufacturer and installer agree to repair or replace fuel-oil pumps that fail in materials or workmanship within specific warranty period.

B. Warranty Period for Fuel-Oil Pumps: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

B. Maximum Operating-Pressure Ratings: 3 psig fuel-oil supply pressure at oil-fired appliances.

C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design restraint and anchors for fuel-oil pumps, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

D. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.

2.2 SUBMERSIBLE FUEL-OIL STORAGE TANK PUMPS

A. Comply with UL 79, UL 87, and UL 343.

1. Impeller: Turbine.
2. Housing and Volute: Cast iron.
3. Bearings: Bronze, self-lubricating.
4. Seals: Mechanical.
5. Shaft: Polished steel.
6. Suspension Piping: Telescoping to accommodate tank diameter and depth of bury.
7. Base: Steel.
8. Pressure Relief: Built in.
9. Discharge Check Valve: Built in.
10. Drive: Direct, close coupled.

B. Controls: Pump controller panel complying with UL 353 and UL 508C and with interlock and terminals for connections to fuel-oil-burning equipment.

1. Maintain minimum manifold pressure with outdoor-air temperature less than 60 deg F.
2. Seven-day schedule.
3. Stage multiple pumps to maintain pressure at a common supply manifold.
4. Alternate pumps to equalize run time.
5. Alarm motor failure.
6. Manual reset dry-run protection.
7. Stop pumps if fuel level falls below pump suction.
8. De-energize and sound alarm for pump, locked-rotor condition.
9. Sound alarm for open circuit and for high and low voltage.
10. Lights indicate normal power on, run, and off conditions.

C. Capacities and Characteristics:

1. Number of Stages: 2.
2. Capacity: 88 gph.
3. Discharge Pressure: 30 feet TDH.
4. Outlet Size: 1” NPS.
5. Motor Speed: 3,450 RPM.
6. Motor Horsepower: ½ HP minimum.
7. Electrical Characteristics:

    a. Volts: 120.
    b. Phase: Single.
    c. Hertz: 60.
    d. Full-Load Amperes: 9.8.
    e. Minimum Circuit Ampacity: 13.0.
    f. Maximum Overcurrent Protection: 25.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

1. Enclosure: Totally enclosed, nonventilated.
2. Enclosure Materials: Stainless-steel.
3. Motor Bearings: Sealed, Permanently Lubricated Ball Bearings.
4. Unusual Service Conditions:

    a. Ambient Temperature: 95F.
    b. Altitude: 10 above sea level.
    c. High humidity.
    d. Coastal, corrosive environment with continuous-duty service.

5. Efficiency: Premium efficient.
6. NEMA Design: Design N.
7. Service Factor: 1.15.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PREPARATION

A. Close equipment shutoff valves before turning off fuel oil to premises or piping section.

B. Comply with NFPA 30 and NFPA 31 requirements for prevention of accidental ignition.

3.3 INSTALLATION OF FUEL-OIL PUMPS

A. Submersible Fuel-Oil Storage Tank Pumps:

1. Suspend pumps from supply piping and anchor to bottom of tank.

B. Install two-piece, full-port ball valves at suction and discharge of pumps. Comply with requirements in Section 230523 "General-Duty Valves for HVAC Piping."

C. Install mechanical leak-detector valves at pump discharge.

D. Install Y-pattern strainer on inlet side of all fuel-oil pumps.

E. Install check valve on discharge of all fuel-oil pumps unless provided with built-in check valve.

F. Install suction piping with minimum fittings and change of direction.

G. Install vacuum and pressure gauge, upstream and downstream, respectively, at each pump to measure the differential pressure across the pump. Pressure gauges are specified in Section 230500 "Common Work Results for HVAC."

3.4 LABELING AND IDENTIFYING

A. Install nameplates and signs on each fuel-oil pump. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Start fuel-oil transfer pumps to verify for proper operation of pump, and check for leaks.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Fuel-oil pumps will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fuel-oil pumps.

END OF SECTION 231213

SECTION 231323 - FACILITY ABOVEGROUND FUEL-OIL STORAGE TANKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Aboveground fuel-oil storage tanks, steel.
2. Aboveground fuel-oil storage tank accessories.
3. Fuel-oil-level gauge system.
4. Fuel-oil leak-detection and monitoring systems.
5. Fuel oil.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and dimensions of individual components and profiles.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Fuel-oil storage tank accessories.
4. Fuel-oil leak-detection and monitoring system.

B. Shop Drawings: For aboveground fuel-oil storage tanks.

1. Include plans, elevations, sections, concrete bases, anchors, and lifting or supporting points.
2. Indicate details of equipment assemblies. Indicate dimensions, components, and location and size of each field connection.
3. Shop Drawing Scale: 1/4 inch per foot.

1.3 INFORMATIONAL SUBMITTALS

A. Site Survey: Plans, drawn to scale, on which fuel-oil storage tanks are indicated and coordinated with other services and utilities.

B. Welding certificates.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-oil equipment and accessories to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Lift and support fuel-oil storage tanks only at designated lifting or supporting points, as shown on Shop Drawings. Do not move or lift tanks unless empty.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of fuel-oil storage tanks that fail in materials or workmanship within specified warranty period.

1. Storage Tanks:

a. Failures include, but are not limited to, the following when used for storage of fuel oil at temperatures not exceeding 150 deg F:

1) Structural failures including cracking, breakup, and collapse.
2) Corrosion failure including external and internal corrosion of steel tanks.

b. Warranty Period: 30 years from date of Final Acceptance.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design restraint and anchors for aboveground fuel-oil storage tanks and equipment, including comprehensive engineering analysis, using performance requirements and design criteria indicated.

B. Wind Performance: Aboveground fuel-oil storage tanks are to withstand the effects of wind determined in accordance with ASCE/SEI 7. See Section 230548.13 "Vibration Controls for HVAC".

2.2 ABOVEGROUND FUEL-OIL STORAGE TANKS, STEEL

A. Source Limitations: Obtain steel, aboveground fuel-oil storage tanks from single manufacturer.

B. Description: UL 142, UL 2085, and STI F941; fire-resistant and protected, double-wall, horizontal steel tank; with primary- and secondary-containment walls.

C. Construction: Fabricated with welded carbon steel and insulation suitable for operation at atmospheric pressure and for storing fuel oil with specific gravity up to 1.1 and with test temperature in accordance with UL 2085.

D. Corrosion Protection: Finish with marine coating including corrosion resistant primer coat and corrosion resistant finish coat.

E. Capacities and Characteristics:

1. Capacity: 20,000 gallons.
2. Fuel: Diesel.

2.3 ABOVEGROUND FUEL-OIL STORAGE TANK ACCESSORIES

A. Tank Manholes:

1. 22-inch- minimum diameter; bolted, flanged, and gasketed; centered on top of tank.

B. Threaded pipe connection fittings on top or sides of tank as indicated, for fill, supply, return, vent, sounding, and gauging. Include cast-iron plugs for shipping.

C. Striker Plates: Inside tank, on bottom below fill, vent, sounding, gauge, and other tube openings.

D. Lifting Lugs: For handling and installation.

E. Supply Tube: Extension of supply piping fitting into tank, terminating 6 inches above tank bottom and cut at a 45-degree angle.

F. Sounding and Gauge Tubes: Extension of fitting into tank, terminating 6 inches above tank bottom and cut at a 45-degree angle.

2.4 FUEL-OIL LEAK-DETECTION AND MONITORING SYSTEMS

A. Fuel-Oil Leak Detection and Monitoring, Cable and Sensor System: Comply with UL 1238.

1. Source Limitations: Obtain cable-and-sensor fuel-oil leak-detection and monitoring system from single manufacturer.
2. Calibrated fuel-oil leak-detection and monitoring system with probes and other sensors and remote alarm panel for fuel-oil storage tanks and fuel-oil piping.
3. Include fittings and devices required for testing.
4. Controls: Electrical, operating on 120 VAC.
5. Calibrated fuel-oil-level gauge complying with UL 1238 with probes or other sensors and remote annunciator panel.
6. Remote Annunciator Panel: With visual and audible, high-tank-level and low-tank-level alarms; fuel indicator with registration in gallons; and overfill alarm. Include gauge volume range that covers fuel-oil storage capacity.
7. Remote Annunciator Panel Controls: Electrical, operating on 120 V ac.

2.5 FUEL OIL

A. Fuel Oil: ASTM D396, Grade No. 2.

B. Diesel Fuel Oil: ASTM D975, Grade No. 2-D, general purpose, high volatility.

2.6 SOURCE QUALITY CONTROL

A. Pressure test and inspect fuel-oil storage tanks, after fabrication and before shipment, in accordance with ASME and the following:

1. Horizontal Steel Aboveground Fuel-Oil Storage Tanks: UL 142 and UL 2085.

B. Affix standards organization's code stamp.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for aboveground fuel-oil storage tanks to verify actual locations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.3 INSTALLATION OF ABOVEGROUND FUEL-OIL STORAGE TANKS

A. Install tank in accordance with NFPA 30 and 31 by a tank-manufacturer-trained and -certified contractor.

B. Install tank bases and supports.

C. Concrete Bases: Anchor aboveground fuel oil storage tank to concrete base in accordance with equipment manufacturer's written instructions and in accordance with seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Use 3000-psig, 28-day, compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

D. Connect piping and vent fittings.

E. Install ground connections.

F. Install tank leak-detection and monitoring devices.

G. Install steel aboveground fuel-oil storage tanks in accordance with STI R912.

H. Install insulated and concrete-vaulted, steel, aboveground fuel-oil storage tanks in accordance with STI R942.

I. Fill storage tanks with fuel oil.

3.4 INSTALLATION OF FUEL-OIL-LEVEL GAUGE SYSTEM

A. Install liquid-level gauge system. Install panel where indicated on Drawings.

3.5 INSTALLATION OF LEAK-DETECTION AND MONITORING SYSTEM

A. Install leak-detection and monitoring system. Install alarm panel where indicated on Drawings.

1. Double-Wall, Fuel-Oil Storage Tanks: Use factory-installed integral probes in interstitial space.
2. Install liquid-level gauge.

3.6 LABELING AND IDENTIFYING

A. Nameplates, pipe identification, and signs are specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.7 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

1. Tanks: Minimum hydrostatic or compressed-air test pressures for fuel-oil storage tanks that have not been factory tested and do not bear the ASME code stamp or a listing mark acceptable to authorities having jurisdiction:
   a. Double-Wall Tanks:
      1) Inner Tanks: Minimum 3 psig and maximum 5 psig.
      2) Interstitial Space: Minimum 3 psig and maximum 5 psig, or 5.3-in. Hg vacuum.
   b. Where vertical height of fill and vent pipes is such that the static head imposed on the bottom of the tank is greater than 10 psig, hydrostatically test the tank and fill and vent pipes to a pressure equal to the static head thus imposed.
   c. Maintain the test pressure for one hour.

B. Aboveground fuel-oil storage tanks will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 231323

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SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plastic pipe and fittings.
2. Transition fittings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation are to be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:

1. Hot-Water Heating Piping: 100 psig at 180 deg F.
2. Chilled-Water Piping: 150 psig at 73 deg F.
3. Makeup-Water Piping: 150 psig at 73 deg F.
4. Condensate-Drain Piping: 150 deg F.
5. Air-Vent Piping: 180 deg F.
6. Pressure-Relief-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 PLASTIC PIPE AND FITTINGS

A. CPVC Plastic Pipe: ASTM F441/F441M, with wall thickness as indicated in "Piping Applications" Article.

1. Source Limitations: Obtain CPVC plastic pipe from single manufacturer.
2. CPVC Socket Fittings: ASTM F438 for Schedule 40 and ASTM F439 for Schedule 80.
3. CPVC Threaded Fittings: ASTM F437, Schedule 80.

B. Smoke and Fire Ratings:

1. Where indicated on Drawings that a plenum-rated piping system is required, the pipe is to be wrapped and/or insulated with fiberglass or mineral wool pipe insulation; field installed.

    a. The system is to have a flame-spread classification of less than 25 and smoke-developed rating of less than 50.
    b. Pipe, wrap, or insulation as a system to comply with the requirements of CAN/ULC-S102.2, ASTM E84, or UL 2846.

c. For insulation required for thermal and condensation conditions, see Section 230719 "HVAC Piping Insulation."

2.3 PIPING JOINING MATERIALS

A. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

B. Solvent Cements for CPVC Piping: ASTM F493.

2.4 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Plastic-to-Metal Transition Fittings:

1. Source Limitations: Obtain plastic-to-metal transition fittings from single manufacturer.
2. Description:

a. CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
b. One end with threaded brass insert and one solvent-cement-socket or threaded end.

3. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.

D. Plastic-to-Metal Transition Unions:

1. Source Limitations: Obtain plastic-to-metal transition unions from single manufacturer.
2. Brass or copper end and solvent-cement-joint end of union to match pipe in size and material.
3. Description:

a. CPVC four-part union.
b. Brass or stainless-steel threaded end.
c. Solvent-cement-joint or threaded plastic end.
d. Rubber O-ring.
e. Union nut.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-Water Heating Piping, Aboveground, NPS 2 (DN 50) and Smaller, to Be the Following:

1. Schedule 40, CPVC plastic pipe and fittings and solvent-welded joints.

B. Hot-Water Heating Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to be:

1. Schedule 80, CPVC plastic pipe and fittings and solvent-welded joints.

C. Chilled-Water Piping, Aboveground, NPS 2 (DN 50) and Smaller, to be:

1. Schedule 40, CPVC plastic pipe and fittings and solvent-welded joints.

D. Chilled-Water Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to be:

1. Schedule 80, CPVC plastic pipe and fittings and solvent-welded joints.

E. Makeup-Water Piping Installed Aboveground to Be:

1. Schedule 40, CPVC plastic pipe and fittings and solvent-welded joints.

F. Condensate-Drain Piping Installed Aboveground to Be:

1. Schedule 40, CPVC plastic pipe and fittings and solvent-welded joints.

G. Air-Vent Piping:

1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems, according to piping manufacturer's written instructions.
2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

H. Pressure-Relief-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed, with metal-to-plastic transition fittings for plastic piping systems, according to piping manufacturer's written instructions.

3.2 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install valves according to Section 230523 "General-Duty Valves for HVAC Piping."

P. Install air vents and pressure-relief valves in accordance with Section 232116 "Hydronic Piping Specialties."

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install shutoff valve immediately upstream of each dielectric fitting.

T. Comply with requirements in Section 230500 "Common Work Results for HVAC" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.

U. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Common Work Results for HVAC."

W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230500 "Common Work Results for HVAC."

X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230500 "Common Work Results for HVAC."

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. CPVC Piping: Join in accordance with ASTM D2846/D2846M Appendix.

3.4 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

B. Install hangers for plastic piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Support horizontal piping within 12 inches of each fitting and coupling.

D. Support vertical runs of CPVC piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support vertical runs of fiberglass piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.5 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections are to be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gauges and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230500 "Common Work Results for HVAC."

3.6 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 230553 "Identification for HVAC Piping and Equipment."

3.7 SYSTEM STARTUP

A. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.

6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

3.8 FIELD QUALITY CONTROL

A. Prepare hydronic piping in accordance with ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure is to be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install pressure-relief valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient-temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure is not to exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9.
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

END OF SECTION 232113

SECTION 232113.13 - UNDERGROUND HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pre-engineered cased piping system.
2. Transition fittings.

1.2 DEFINITIONS

A. Invert: Vertical distance from Project datum reference point to bottom interior pipe surface.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Pre-engineered cased piping system components.

B. Shop Drawings: For underground hydronic piping. Signed and sealed by a professional engineer.

1. Include calculations showing requirements for expansion compensation for underground piping.
2. Show expansion compensators, offsets, and loops with appropriate materials to allow piping movement at required locations. Show anchors and guides that restrain piping movement with calculated loads and show concrete thrust block dimensions.
3. Show pipe sizes, locations, inverts, and pitch. Show piping in trench, piping in conduit, and cased pipe with details showing clearances between piping.
4. Show insulation thickness.

C. Delegated Design Submittal: For underground hydronic piping systems indicated to comply with performance requirements and design criteria, including analysis data and design drawings signed and sealed by the professional engineer responsible for their preparation.

1. Include design calculations and details for selecting thermal expansion and thrust restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

1.6 FIELD CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt utilities serving occupied facilities unless permitted under the following conditions and then only after arranging to provide temporary utility services in accordance with requirements indicated:

1. Notify Architect, Construction Manager, and Owner no fewer than two days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without written permission.

1.7 COORDINATION

A. Coordinate pipe-fitting pressure classes with products specified in related Sections.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing hydronic piping systems with the following minimum working-pressure ratings:

1. Hot-Water Piping: 150 psig at 200 deg F.
2. Chilled-Water Piping: 150 psig at 100 deg F.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design underground hydronic piping systems, including restraints and anchors.

2.2 PLASTIC PIPE AND FITTINGS

A. CPVC Plastic:

1. Pipe: ASTM F441/F441M, Schedules 40 and 80, plain ends. Make joints as indicated in "Piping Application" Article.
2. Pipe Fittings: Socket-type pipe fittings, ASTM F438 for Schedule 40 pipe; ASTM F439 for Schedule 80 pipe.
3. Solvent Cements: ASTM F493.

B. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.3 TRANSITION FITTINGS

A. Source Limitations: Obtain transition fittings from single source from single manufacturer.

B. Plastic-to-Metal Transition Fittings: CPVC one-piece fitting with one threaded brass or copper insert and one Schedule 80 solvent-cemented-joint end.

2.4 PRE-ENGINEERED CASED PIPING SYSTEM

A. Source Limitations: Obtain piping system from single source from single manufacturer.

B. Description: Factory-fabricated piping with carrier pipe, insulation, and casing.

C. Carrier Pipe: Materials as indicated in "Piping Application" Article. See articles in this Section for required carrier pipe material characteristics.

D. Carrier Pipe Insulation:

1. Polyurethane Foam Pipe Insulation: Rigid, cellular, and high-pressure injected between carrier pipe and jacket.

a. Comply with ASTM C591; thermal conductivity (k-value) may not exceed 0.165 Btu x in./h x sq. ft. x deg F at 75 deg F after 180 days of aging.

E. Casing: HDPE or PVC.

F. Casing accessories include the following:

1. Joint Kit: Half-shell, pourable or split insulation, casing sleeve, and shrink-wrap sleeve.
2. Expansion Blanket: Elastomeric foam, formed to fit over piping.
3. End Seals: Shrink wrap the casing material to seal watertight around casing and carrier pipe.

G. Manholes: Black steel with lifting eyes.

1. Finish: Spray-applied urethane, minimum 30 mils thick.
2. Access: 30-inch-diameter waterproof cover with gasket, ladder, and two 6-inch vents, one high and one low, extending above grade with rain caps.
3. Conduit Stub-Outs and Seals: Welded steel with drain and vent openings.
4. Sump: 12 inches in diameter; 12 inches deep.
5. Floatation Anchor: Oversized bottom keyed into concrete base.

H. Cover: With polyurethane foam insulation with an HDPE jacket; thickness indicated in "Piping Application" Article.

I. Source Quality Control: Factory test carrier pipe to 150 percent of operating pressure of system. Furnish test certificates.

PART 3 - EXECUTION

3.1 EARTHWORK

A. See Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATION

A. Hot-Water Heating Piping:

1. NPS 2-1/2 and larger to be the following:

a. Schedule 80 CPVC plastic pipe and fittings and solvent-welded joints.

2. Cased Piping: Polyurethane carrier-pipe insulation.

a. Piping Insulation Thickness: 2 inches.

B. Chilled-Water Piping:

1. NPS 2-1/2 and larger to be the following:

a. Schedule 80 CPVC plastic pipe and fittings and solvent-welded joints.

2. Cased Piping: Polyurethane carrier-pipe insulation.

a. Piping Insulation Thickness: 2 inches.

3.3 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Remove standing water in the bottom of trench.

C. Bed the pipe on a minimum 6-inch layer of pipe system manufacturer's recommended granular fill material with a minimum 6-inch clearance between pipes.

D. Do not backfill piping trench until field quality-control testing has been completed and results approved.

E. Install piping at uniform grade of 0.2 percent. Install required fittings to accommodate capped drains at low points and elsewhere as required for system drainage. Install capped manual air vents at high points.

1. Maintain continuous bedding under piping. Do not leave gaps in pipe bedding, allowing pipe to sag between contact points with the bedding.

F. In conduits, install drain valves at low points and manual air vents at high points.

G. Install components with pressure rating equal to or greater than system operating pressure.

H. Install piping in straight lines. Do not bend pipe.

I. Install fittings for changes in direction and branch connections.

J. See Section 230500 "Common Work Results for HVAC" for sleeves and mechanical sleeve seals through exterior building walls.

K. Secure anchors with concrete thrust blocks. Concrete is specified in Section 033000 "Cast-in-Place Concrete."

L. Connect to hydronic piping where it passes through the building wall. Hydronic piping inside the building is specified in Section 232113 "Hydronic Piping."

M. See Section 230523 "General-Duty Valves for HVAC Piping" for sleeves and mechanical sleeve seals through exterior building walls.

N. Secure anchors and fittings where piping changes direction, and where elsewhere required by manufacturer's written installation instructions, with concrete thrust blocks. Concrete is specified in Section 033000 "Cast-in-Place Concrete."

O. See Section 134713 "Cathodic Protection" for cathodic devices and connections to piping and conduit systems.

P. Apply bitumastic coating to carbon-steel anchors and guides. Pour concrete thrust blocks and anchors. See Section 033000 "Cast-in-Place Concrete" for concrete and reinforcement.

Q. After field quality-control testing is complete, backfill with 6 inches of clean, granular material in accordance with piping system manufacturer's written instructions. If mechanical compaction is required, manually backfill to 12 inches before using mechanical-compaction equipment.

3.4 JOINT CONSTRUCTION

A. Join pipe and fittings in accordance with the following requirements and Section 232113 "Hydronic Piping":

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

B. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. CPVC Piping: Join in accordance with ASTM D2846/D2846M Appendix X2.

C. marks on pipe after assembly.

D. Conduit and Cased Piping Joints: Assemble sections and finish joints with pourable or split insulation and exterior jacket sleeve, and apply shrink-wrap seals.

3.5 IDENTIFICATION

A. Install continuous plastic underground warning tapes during backfilling of trenches for underground hydronic piping. Locate tapes 6 to 8 inches below finished grade, directly over piping. See Section 312000 "Earth Moving" for warning-tape materials and devices and their installation.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

1. Prepare hydronic piping for testing in accordance with ASME B31.9 and as follows:

    a. Leave joints, including welds, uninsulated and exposed for examination during test.
    b. Isolate equipment and instrumentation. Do not subject equipment and instrumentation to test pressure.
    c. Install relief valve set to relieve at pressure no more than one-third higher than test pressure.
    d. Fill system with water. Where there is risk of freezing, perform testing with air or liquid that will not freeze or cause damage to piping system materials.
    e. For hydrostatic testing, install vents at high points to release trapped air while filling system. Remove test liquid at accessible low points.

2. Test hydronic piping as follows:

    a. Subject hydronic piping to hydrostatic test pressure that is not less than 1.5 times system design pressure.
    b. After hydrostatic test pressure has been applied for 10 minutes, examine joints for leakage. Remake leaking joints using new materials and repeat hydrostatic test until no leaks exist.
    c. Do not pressurize carrier pipe with air.
    d. Maintain test pressure for four hours with no loss of pressure.

3. Test conduit as follows:

    a. Seal vents and drains and subject conduit to 15-psig compressed air for four hours with no loss of pressure. Repair leaks and retest.

C. Piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. When successful testing is complete, flush carrier piping to remove dirt or debris remaining after construction. Drain piping after flushing is complete.

F. Fill underground piping system with permanent system liquid prior to system testing and balancing.

END OF SECTION 232113.13

SECTION 232116 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hydronic specialty valves.
2. Air vents.
3. Expansion tanks and fittings.
4. Air/dirt separators and purgers.
5. Strainers.
6. Flexible connectors.

B. Related Requirements:

1. Section 230500 "Common Work Results for HVAC" for expansion fittings and loops.
2. Section 230523 "General-Duty Valves for HVAC Piping" for specification and installation requirements for general-duty valves common to most piping systems.
3. Section 230923 "Direct Digital Control System for HVAC" for automatic control valve and sensor specifications, installation requirements, and locations.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product:

1. Include construction details and material descriptions for hydronic piping specialties.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
3. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For hydronic piping specialties to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Pressure-relief and safety-relief valves and pressure vessels bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME BPVC, Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 HYDRONIC SPECIALTY VALVES

A. Bronze, Calibrated-Orifice, Balancing Valves:

1. Body: Bronze, ball or plug type with calibrated orifice or venturi.
2. Ball: Brass or stainless steel.
3. Plug: Resin.
4. Seat: PTFE.
5. End Connections: Threaded or socket.
6. Pressure Gauge Connections: Integral seals for portable differential pressure meter.
7. Handle Style: Lever, with memory stop to retain set position.
8. CWP Rating: Minimum 125 psig.
9. Maximum Operating Temperature: 250 deg F.

B. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.

1. Body: Bronze or brass.
2. Disc: EPDM.
3. Seat: Brass.
4. Stem Seals: EPDM O-rings.
5. Diaphragm: EPDM.
6. Low inlet-pressure check valve.
7. Inlet Strainer: stanless-steel, removable without system shutdown.
8. Valve Seat and Stem: Noncorrosive.
9. Valve Size and Capacity: As indicated on Drawings.
10. Operating Pressure: Factory set and field adjustable.

C. Diaphragm-Operated Pressure-Relief Valves: ASME labeled.

1. Body: Bronze or brass.
2. Disc: Brass.
3. Seat: Brass.
4. Stem Seals: EPDM O-rings.
5. Diaphragm: EPDM.
6. Valve Seat and Stem: Noncorrosive.
7. Valve Size, Capacity, and Operating Pressure: Comply with ASME BPVC, Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

D. Automatic Flow-Control Valves:

1. Body: Brass.
2. Combination Assemblies: Include bronze or brass-alloy ball valve.
3. Identification Tag: Marked with zone identification, valve number, and flow rate.
4. Size and Capacity: For each application, provide a valve with rated capacity equal to or greater than capacity of device being served.
5. Performance: Maintain constant flow within plus or minus 10 percent, regardless of system pressure fluctuations.
6. Minimum CWP Rating: 175 psig.
7. Maximum Operating Temperature: 200 deg F.

2.2 AIR VENTS

A. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

B. Automatic Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/4.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 240 deg F.

2.3 EXPANSION TANKS AND FITTINGS

A. Bladder-Type ASME Expansion Tanks:

1. Tank: Welded steel, rated for 125 psig working pressure and 375 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled in accordance with ASME BPVC, Section VIII, Division 1.
2. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity. Field-replaceable bladder.
3. Sight glass.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

2.4 AIR/DIRT SEPARATORS

A. Coalescing-Type Air and Dirt Separators:

1. Tank: Fabricated steel tank; ASME constructed and stamped for 125 psig working pressure and 270 deg F maximum operating temperature.
2. Coalescing Medium: Stainless steel.
3. Air Vent: Threaded to top of separator.
4. Inline Inlet and Outlet Connections: Threaded for NPS 2 (DN 50) and smaller; Class 150 flanged connections for NPS 2-1/2 and larger.
5. Blowdown Connection: Threaded to bottom of separator.
6. Size: Match system flow capacity.

2.5 STRAINERS

A. Y-Pattern Strainers:

1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: Stainless steel, 60-mesh strainer, or perforated stainless steel basket.
4. CWP Rating: 125 psig.

2.6 FLEXIBLE CONNECTORS

A. Stainless Steel Bellows, Flexible Connectors:

1. Body: Stainless steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine all piping specialties for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Examine threads on all devices for form and cleanliness.

C. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

D. Do not attempt to repair defective piping specialties; replace with new devices. Remove defective piping specialties from site.

3.2 INSTALLATION OF VALVES

A. Install calibrated-orifice balancing valve at each branch connection to return main.

B. Install calibrated-orifice, balancing valve in the return pipe of each heating or cooling terminal.

C. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

D. Install pressure-relief and safety-relief valves at hot-water generators and elsewhere as required by ASME BPVC. Pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME BPVC, Section VIII, Division 1, for installation requirements.

3.3 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only.

1. Provide air outlet drain line full size of air outlet to floor drain or to other point indicated on Drawings.

C. Install manual vents at heat-transfer coils and elsewhere as required for air venting.

D. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve full size of separator outlet; extend full size to nearest floor drain.

E. Install diaphragm- or bladder-type expansion tanks on the floor.

F. Vent and purge air from hydronic system and ensure that tank is properly charged with air to suit system Project requirements.

END OF SECTION 232116

1

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Separately coupled, base-mounted, end-suction centrifugal pumps.

1.2 DEFINITIONS

A. EPDM: Ethylene propylene diene monomer.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of pump.

1. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated.
2. Indicate pump's operating point on curves.

B. Shop Drawings: For each pump.

1. Show pump layout and connections.
2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mechanical Seals: One mechanical seal(s) for each pump.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Source Limitations: Obtain pumps from single source from single manufacturer.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump with flexible shaft coupling as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.

C. Capacities and Characteristics: Refer to Schedule on Design Drawings.

2.3 PUMP SPECIALTY FITTINGS

A. Suction Diffuser:

1. Angle pattern.
2. 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting.
3. Bronze 16-mesh wire startup and Type 304 stainless steel permanent strainers with 3/16-inch.
4. Type 304 stainless steel straightening vanes.
5. Drain plug.
6. Factory-fabricated support.

B. Triple-Duty Valve:

1. Angle or straight pattern.
2. 175-psig pressure rating, cast-iron body, pump-discharge fitting.
3. Valve with multi-turn stem and memory stop to allow valve to be returned to its original position after shutoff.
4. Brass valve disc with EPDM rubber seat.
5. Type 304 stainless steel valve stem.
6. Drain plug and bronze-fitted shutoff, balancing, and check valve features.
7. Brass gauge ports with integral check valve and orifice for flow measurement.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations for suitable conditions where pumps will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

C. Equipment Mounting:

1. Install base-mounted pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

3.3 ALIGNMENT

A. Engage a factory-authorized service representative to perform alignment service.

B. Comply with requirements in HI standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

C. Comply with pump and coupling manufacturers' written instructions.

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.4 PIPING CONNECTIONS

A. Where installing piping adjacent to pump, allow space for service and maintenance.

B. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

C. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

D. Install triple-duty valve on discharge side of pumps.

E. Install suction diffuser and shutoff valve on suction side of pumps.

1. Use startup strainer for initial system startup. Install permanent strainer element before turnover of system to Owner.

F. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

G. Install pressure gauges on pump suction and discharge or at integral pressure-gauge tapping, or install single gauge with multiple-input selector valve.

3.5 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.6 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping. Use startup strainer for initial startup.
4. Perform the following startup checks for each pump before starting:

    a. Verify bearing lubrication.
    b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    c. Verify that pump is rotating in correct direction.

5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

3.8 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Hydronic pumps will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 232123

1

SECTION 232513 - WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Water treatment for closed-loop hydronic systems.
2. Manual chemical-feed equipment.
3. Chemicals.

1.2 DEFINITIONS

A. TDS: Total dissolved solids consist of salts and other materials that combine with water as a solution.

B. TSS: Total suspended solids include both organic and inorganic solids that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:

1. Bypass feeders.
2. Water meters.
3. Inhibitor injection timers.
4. pH controllers.
5. Chemical solution tanks.
6. Injection pumps.
7. Chemical-treatment test equipment.
8. Chemical material safety data sheets.
9. Inhibited ethylene glycol.
10. Inhibited propylene glycol.

B. Shop Drawings: Pretreatment and chemical-treatment equipment, showing tanks, maintenance space required, and piping connections to hydronic systems.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Water-Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.

B. Field quality-control reports.

C. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in "Performance Requirements" Article.

D. Water Analysis: Illustrate water quality available at Project site.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider, capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide all hardware, chemicals, and other material necessary to maintain HVAC water quality in all systems, as indicated in this Specification. Water quality for hydronic systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of hydronic equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, hydronic system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed hydronic systems, including hot-water heating below 250 deg F and chilled water shall have the following water qualities:

1. pH: Maintain a value within 8.0 and 10.5.
2. Alkalinity: Maintain a value within 100 to 300 ppm as CaCO(3).
3. Steel Corrosion Inhibiters: Provide sufficient inhibitors to limit mild steel corrosion to <**1** mils per year. Maintain soluble iron concentrations at or below 0.1 ppp mg/L.
4. Yellow Metal Corrosion Inhibitor: Provide sufficient copper and brass corrosion inhibitors to limit copper corrosion to 0.3 mils per year. Maintain soluble copper concentrations at or below 0.1 ppm mg/L.
5. Scale Control: Provide softened water for initial fill and makeup. Where softened water is not used, provide sufficient scale inhibitors to prevent formation of scale and maintain all scale-forming material in solution.
6. Dispersants: Provide sufficient dispersants to prevent sedimentation of fine particulate matter.
7. Microbiological Limits:

    a. Total Aerobic Plate Count: Maintain a maximum value of <1,000 CFU/mL.
    b. Total Anaerobic Plate Count: Maintain a maximum value of <100 CFU/mL.
    c. Nitrate Reducers: Maintain a maximum value of <100 CFU/mL.
    d. Sulfate Reducers: Maintain a maximum value of <10 CFU/mL.
    e. Iron Bacteria: Maintain a maximum value of <100 CFU/mL.

2.2 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass Feeders: Provide steel feeders with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Provide quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.

1. Capacity: 5 gal..
2. Minimum Working Pressure: 175 psig.

2.3 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer, compatible with piping system components and connected equipment, and able to attain water quality specified in "Performance Requirements" Article.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine the quality of water available at Project site.

3.2 INSTALLATION

A. Install chemical-application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate. Install all chemical application equipment within a spill-containment area without floor drain.

B. Install water-testing equipment on wall near water-chemical-application equipment.

C. Install interconnecting control wiring for chemical-treatment controls and sensors.

D. Mount sensors and injectors in piping circuits.

E. Bypass Feeders: Install in closed hydronic systems, including hot-water heating, chilled water,, and equip with the following:

1. Install bypass feeder in a bypass circuit around circulating pumps unless indicated otherwise on Drawings.
2. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
3. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below the feeder inlet.
4. Install a swing check on the inlet after the isolation valve.

F. Install automatic fluid make-up equipment for glycol water system, and include the following:

1. Chemical solution tanks.
2. Chemical solution injection pumps.
3. Water meter in makeup supply to system.

4. Pressure switch to operate injection pump as necessary to maintain glycol system pressure.

3.3 PIPING CONNECTIONS

A. Piping installation requirement are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Section 232113 "Hydronic Piping."

D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 230523 "General-Duty Valves for HVAC Piping."

E. Comply with requirements in Section 221119 "Domestic Water Piping Specialties" for backflow preventers required in makeup-water connections to potable-water systems.

3.4 FIELD QUALITY CONTROL

A. Testing Agency:

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of hydronic systems' startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
8. Repair leaks and defects with new materials, and retest piping until no leaks exist.

D. Equipment will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. At eight-week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality

within performance requirements specified in this Section. Submit written reports of water analysis, advising Owner of changes necessary to adhere to "Performance Requirements" Article.

G. Comply with ASTM D3370 and with the following standards:

1. Silica: ASTM D859.
2. Acidity and Alkalinity: ASTM D1067.
3. Iron: ASTM D1068.
4. Water Hardness: ASTM D1126.

3.5 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above, to inhibit corrosion and scale formation for hydronic piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:

1. Initial water analysis and HVAC water-treatment recommendations.
2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
3. Periodic field service and consultation.
4. Customer report charts and log sheets.
5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

END OF SECTION 232513

1

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round and flat-oval ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.

B. Related Requirements:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

B. Delegated Design Submittals:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and with performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports are to withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

C. Wind Performance: Ducts are to withstand the effects of wind determined in accordance with to ASCE/SEI 7.

D. Airstream Surfaces: Surfaces in contact with airstream comply with requirements in ASHRAE 62.1.

E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."

F. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

G. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of aluminum unless otherwise indicated.

B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. For ducts with longest side less than 36 inches, select joint types in accordance with Figure 2-1.
2. For ducts with longest side 36 inches or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.

C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." All longitudinal seams are to be Pittsburgh lock seams unless otherwise specified for specific application.

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of aluminum unless otherwise indicated.

B. Source Limitations: Obtain single-wall round ducts and fittings from single manufacturer.

C. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.

E. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials are to be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Aluminum Sheets: Comply with ASTM B209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

2.5 DUCT LINER

A. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C534/C534M, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

1. Source Limitations: Obtain flexible elastomeric duct liner from single manufacturer.
2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

B. Insulation Pins and Washers:

1. Pins: Pins shall be made of corrosion-resistant aluminum alloy conforming to ASTM B209. Pins shall have a minimum diameter of 12-gauge (0.105 inches for adequate holding strength. Pins shall be available in self-adhesive, perforated base, or weld-on designs, as required for the application. The length of the pin shall be selected to match the thickness of the elastomeric duct liner plus a minimum 3/8" (9.5 mm) extension for securing the washer.
2. Washers: Washers shall be flat or domed, constructed of aluminum alloy to prevent galvanic corrosion with aluminum ductwork. The washer shall have a minimum diameter of 1-3/16 inches (30 mm) to properly distribute the load on the duct liner. Nylon or plastic-coated washers may be used to minimize thermal bridging or condensation issues. Washers shall have a locking mechanism to ensure proper attachment to the pin

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm or greater.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

    a. Fan discharges.
    b. Intervals of lined duct preceding unlined duct.
    c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

9. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.6 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets are to be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10 inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant: Comply with ASTM C920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. Round Duct Joint O-Ring Seals:

1. Seal is to provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and is to be rated for10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.7 HANGERS AND SUPPORTS

A. Hanger Rods: Stainless-steel, all-thread rods.

B. Steel Cables for Stainless Steel Ducts: Stainless steel complying with ASTM A492.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

D. Trapeze and Riser Supports:

1. Supports for Aluminum Ducts: Aluminum or stainless-steel.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.

B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts in maximum practical lengths with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

J. Install fire dampers where indicated on Drawings and as required by code, and by local authorities having jurisdiction. Comply with requirements in Section 233300 "Air Duct Accessories" for fire dampers and specific installation requirements of the damper UL listing.

K. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

M. Elbows: Use long-radius elbows wherever they fit.

1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches and smaller and a minimum of five segments for 14 inches and larger.

N. Branch Connections: Use lateral or conical branch connections.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter.

D. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts at a minimum to the following seal classes in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class C.
4. Outdoor, Return-Air Ducts: Seal Class C.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 DUCTWORK CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible aluminum primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.7 FIELD QUALITY CONTROL

A. Perform inspections.

B. Duct System Cleanliness Inspection:

1. Visually inspect duct system to ensure that no visible contaminants are present.

C. Duct system will be considered defective if it does not pass inspections.

D. Prepare test and inspection reports.

3.8 STARTUP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.9 DUCT SCHEDULE

A. Fabricate ducts with aluminum sheet except as otherwise indicated and as follows:

1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.

B. Intermediate Reinforcement:

1. Aluminum Ducts: Aluminum.

C. Liner:

1. Interior Supply-Air Ducts: Flexible elastomeric, 1 inch thick.

2. Exterior Supply-Air Ducts: Flexible elastomeric, 2 inch thick
3. Interior Return-Air Ducts: Flexible elastomeric, 5/8 inch thick.
4. Exterior Return -Air Ducts: Flexible elastomeric, 2 inch thick
5. Exhaust-Air Ducts: Flexible elastomeric, 5/8 inch thick, within 20 feet of exterior opening.
6. Supply Fan Plenums: Flexible elastomeric, 1 inch thick.
7. Transfer Ducts: Flexible elastomeric, 5/8 inch thick.

D. Elbow Configuration:

1. Rectangular Duct - Requirements for Different Velocities: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Velocity 1000 fpm or Lower:

1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2) Mitered Type RE 4 without vanes.

b. Velocity 1000 to 1500 fpm:

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

c. Velocity 1500 fpm or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct - Requirements for All Velocities: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.

3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

E. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Conical spin in.

2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1000 fpm or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm: Conical tap.
c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manual volume dampers.
2. Fire dampers.
3. Smoke dampers.
4. Combination fire and smoke dampers.
5. Flange connectors.
6. Turning vanes.
7. Duct-mounted access doors.
8. Flexible connectors.
9. Duct accessory hardware.

B. Related Requirements:

1. Section 233346 "Flexible Ducts" for insulated and non-insulated flexible ducts.
2. Section 233723 "HVAC Gravity Ventilators" for roof-mounted ventilator caps.
3. Section 283111 "Fire Alarm and Detection " for duct-mounted fire and smoke detectors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details, and attachments to other work.

1. Detail duct accessories' fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.
b. Manual volume damper installations.
c. Fire-damper, smoke-damper, combination fire- and smoke-damper installations, including sleeves; and duct-mounted access doors.
d. Duct security bars.
e. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 90A and NFPA 90B.

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MANUAL VOLUME DAMPERS

A. Standard, Aluminum, Manual Volume Dampers:

1. Performance:

a. Leakage Rating Class III: Leakage not exceeding 40 cfm/sq. ft. against 1-inch wg differential static pressure.

2. Construction:

a. Linkage out of airstream.
b. Suitable for horizontal or vertical airflow applications.

3. Frames:

a. Hat-shaped, 0.10-inch-thick, aluminum sheet channels.
b. Flanges for attaching to walls and flangeless frames for installing in ducts.

4. Blades:

a. Multiple or single blade.
b. Parallel- or opposed-blade design.
c. Stiffen damper blades for stability.
d. Roll-Formed Aluminum Blades: 0.10-inch-thick aluminum sheet.

5. Blade Axles: Nonferrous metal.
6. Bearings:

a. Oil-impregnated bronze.
b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.

7. Tie Bars and Brackets: Aluminum.
8. Locking device to hold damper blades in a fixed position without vibration.

2.3 FIRE DAMPERS

A. Type: Dynamic; rated and labeled in accordance with UL 555 by an NRTL.

B. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000 fpm velocity.

C. Fire Rating: 1-1/2 and 3 hours.

D. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed galvanized steel; with mitered and interlocking corners; gauge in accordance with UL listing.

E. Mounting Sleeve: Factory- or field-installed, stainless steel; gauge in accordance with UL listing.

F. Mounting Orientation: Vertical or horizontal as indicated.

G. Blades: Roll-formed stainless steel, interlocking. Material gauge is to be in accordance with UL listing.

H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

I. Heat-Responsive Device:

1. Replaceable, 165 deg F rated, fusible links.

2.4 FLANGE CONNECTORS

A. Description: Add-on or roll-formed, factory fabricated, slide-on transverse flange connectors, gaskets, and components.

B. Material: Aluminum.

C. Gauge and Shape: Match connecting ductwork.

2.5 TURNING VANES

A. Manufactured Turning Vanes for Metal Ducts: Fabricate curved blades of aluminum; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

B. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

C. Vane Construction:

1. Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.6 DUCT-MOUNTED ACCESS DOORS

A. Duct-Mounted Access Doors: Fabricate access panels in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 7-2 (7-2M), "Duct Access Doors and Panels," and Figure 7-3, "Access Doors - Round Duct."

1. Door:

    a. Double wall, rectangular.
    b. 0.032-inch thick aluminum door panel.
    c. Vision panel.
    d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
    e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Aluminum, with bend-over tabs and foam gaskets.

    a. 0.032-inch-thick aluminum frame.

3. Number of Hinges and Locks:

    a. Access Doors Less Than 12 Inches Square: Two hinges with sash lock.
    b. Access Doors up to 18 Inches Square: Continuous and two sash locks.
    c. Access Doors up to 24 by 48 Inches: Continuous and two compression latches.

2.7 FLEXIBLE CONNECTORS

A. Fire-Performance Characteristics: Adhesives, sealants, fabric materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Materials: Flame-retardant or noncombustible fabrics.

D. Coatings and Adhesives: Comply with UL 181, Class 1.

E. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch-wide, 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.

F. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

2.8 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.9 MATERIALS

A. Aluminum Sheets: Comply with ASTM B209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, one-side bright finish for exposed ducts.

B. Extruded Aluminum: Comply with ASTM B221, Alloy 6063, Temper T6.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories in accordance with applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116 for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless steel accessories in stainless steel ducts, and aluminum accessories in aluminum ducts.

C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install aluminum volume dampers in aluminum ducts.

D. Set dampers to fully open position before testing, adjusting, and balancing.

E. Install test holes at fan inlets and outlets and elsewhere as indicated and as needed for testing and balancing.

F. Install fire dampers in accordance with UL listing.

G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. At outdoor-air intakes and mixed-air plenums.
3. Downstream from manual volume dampers, control dampers, and equipment.
4. Adjacent to and close enough to fire dampers, to reset or reinstall fusible links. Access doors for access to fire dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.

5. At each change in direction and at maximum 50-ft. spacing.
6. Upstream from turning vanes.
7. Control devices requiring inspection.
8. Elsewhere as indicated.

H. Install access doors with swing against duct static pressure.

I. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

J. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

K. Install flexible connectors to connect ducts to equipment.

L. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors, and verify that size and location of access doors are adequate to perform required operation.
3. Operate fire dampers to verify full range of movement and that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation, and verify that vanes do not move or rattle.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

SECTION 233346 - FLEXIBLE DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Flexible ducts, insulated.
2. Flexible duct connectors.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Flexible ducts, insulated.
2. Flexible duct connectors.

B. Product Data Submittals: For each type of product.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A and NFPA 90B.

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials must be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

C. Comply with the Air Duct Council's (formerly, Air Diffusion Council) "ADC Flexible Air Duct Test Code - FD 72-R1" and "Flexible Duct Performance & Installation Standards."

D. Comply with ASTM E96/E96M.

2.2 FLEXIBLE DUCTS, INSULATED

A. Standard: Product is to be UL 181 listed and bearing the UL label.

B. Flexible Ducts, Insulated - Class 1, Multiple Layers of Aluminum Laminate Supported by Helically Wound, Spring-Steel Wire; Fibrous-Glass Insulation:
1. Pressure Rating: 10 inch wg positive and 1.0 inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.
4. Insulation R-Value: R6.
5. Vapor-Barrier Film: Aluminized.

2.3 FLEXIBLE DUCT CONNECTORS

A. Clamps: Stainless steel band with stainless steel or zinc-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

PART 3 - EXECUTION

3.1 INSTALLATION OF FLEXIBLE DUCTS

A. Install flexible ducts in accordance with applicable details in the following publications:

1. ADC's "Flexible Duct Performance & Installation Standards" for flexible ducts.
2. NAIMA AH116.
3. SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.
4. SMACNA's "Fibrous Glass Duct Construction Standards" for fibrous-glass ducts.

B. Install in indoor applications only. Do not install flexible duct in locations where it will be exposed to UV lighting.

C. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

D. Connect diffusers to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

E. Connect flexible ducts to metal ducts with adhesive plus draw bands.

F. Installation:

1. Install ducts fully extended.
2. Do not bend ducts across sharp corners.
3. Bends of flexible ducting must not exceed a minimum of one-duct diameter.
4. Avoid contact with metal fixtures, water lines, pipes, or conduits.
5. Install flexible ducts in a direct line, without sags, twists, or turns.
6. Install in accordance with ADC instructions.

G. Supporting Flexible Ducts:

1. Support flexible duct at manufacturer's recommended intervals, but at no greater distance than 4 ft.. Provide sufficient support so that maximum centerline sag is 1/2 in. per ft. between supports. A connection to rigid duct or equipment may be considered a support joint.
2. Install extra supports at bends placed approximately one-duct diameter from center line of the bend.
3. Ducts may rest on ceiling joists or truss supports. Spacing between supports must not exceed the maximum spacing in accordance with manufacturer's written installation instructions.
4. Vertically installed ducts must be stabilized by support straps at a maximum of 72 inches o.c.

END OF SECTION 233346

SECTION 233400 - HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fans, centrifugal, inline - square.
2. Ventilators, centrifugal - roof-mounted downblast.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
b. Rated capacities, furnished specialties, and accessories for each fan.
c. Fans:

1) Certified fan performance curves with system operating conditions indicated.
2) Certified fan sound-power ratings.
3) Fan construction and accessories.
4) Motor ratings and electrical characteristics, plus motor and electrical accessories.
5) Fan speed controllers.

d. Material thickness and finishes, including color charts.
e. Dampers, including housings, linkages, and operators.

1.3 INFORMATIONAL SUBMITTALS

A. Startup service reports.

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fans and ventilators, include the following:

1. Operation in normal and emergency modes.
2. Operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.

2.2 FANS, CENTRIFUGAL, INLINE - SQUARE

A. Description: Refer to schedule on design drawings.

2.3 VENTILATORS, CENTRIFUGAL - ROOF-MOUNTED DOWNBLAST

A. Description: Refer to schedule on design drawings.

2.4 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

2.5 SOURCE QUALITY CONTROL

A. AMCA Certification for Fan Sound Performance Rating: Test, rate, and label in accordance with AMCA 311.

B. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install fans level and plumb.

B. Disassemble and reassemble units, as required for moving to the final location, in accordance with manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

D. Equipment Mounting:
   1. Install roof-mounted fans on roof curbs or support steel. See Drawings for specific requirements.
   2. Support duct-mounted and other hanging fans directly from the building structure, using suitable hanging systems as specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

E. Curb Support, Prefabricated: Rail-type wood support provided by fan manufacturer.

F. Install units with adequate clearances for service and maintenance.

G. Label fans in accordance with requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 DUCTWORK CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Where installing ducts adjacent to fans, allow space for service and maintenance.

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate is to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 STARTUP SERVICE:

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify that cleaning and adjusting are complete.

5. For direct-drive fans, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation.
6. For belt-drive fans, disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
7. Adjust belt tension.
8. Adjust damper linkages for proper damper operation.
9. Verify lubrication for bearings and other moving parts.
10. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
11. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
12. Shut unit down and reconnect automatic temperature-control operators.
13. Remove and replace malfunctioning units and retest as specified above.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Lubricate bearings.

C. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.7 CLEANING

A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust.

3.8 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

1. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safeties.
3. Fans and components will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC fans.

END OF SECTION 233400

SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Modulating, single-duct air terminal units.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of air terminal unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Instructions for resetting minimum and maximum air volumes.
b. Instructions for adjusting software set points.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a Qualified Electrical Testing Laboratory, and marked for intended location and application.

2.2 MODULATING, SINGLE-DUCT AIR TERMINAL UNITS

A. Description: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

B. Casing: Minimum 20-gauge- thick galvanized steel.

1. Casing Liner: Comply with requirements in "Casing Liner" Article below for with "Foil-Faced Liner" Subparagraph.
2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections, size matching inlet size.
4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.

C. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.

D. Velocity Sensors: Multipoint array with velocity inlet sensors.

E. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch. Include manual air vent and drain valve. Provide hydronic heating coils for air terminal units scheduled on Drawings.

F. Direct Digital Controls:

1. Terminal Unit Controller, Section 230923: Controller is to be factory mounted and wired by air terminal manufacturers; unit controllers, integrated actuators, and room sensors to be furnished under Section 230923 "Direct Digital Controls (DDC) for HVAC."

2.3 SOURCE QUALITY CONTROL

A. AHRI 880 Certification: Test, rate, and label assembled air terminal units in accordance with AHRI 880.

B. Water Coils: Factory pressure test to 300 psig in accordance with AHRI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" and Section 233113 "Metal Ducts" for hangers and supports.

B. Install air terminal units according to NFPA 90A.

C. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.2 PIPING CONNECTIONS

A. Where installing piping adjacent to air terminal unit, allow space for service and maintenance.

B. Hot-Water Piping: Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties," and connect heating coils to supply piping with

shutoff valve, strainer, control valve, and union or flange; and to return piping with balancing valve and union or flange.

3.3 DUCTWORK CONNECTIONS

A. Comply with requirements in Section 233113 "Metal Ducts" for connecting ducts to air terminal units.

B. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

3.4 ELECTRICAL CONNECTIONS

A. Install field power to each air terminal unit electrical power connection. Coordinate with air terminal unit manufacturer and installers.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 IDENTIFICATION

A. Label each air terminal unit with drawing designation, nominal airflow, maximum and minimum factory-set airflows, and coil type. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.

2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.

3.8 ADJUSTING

A. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air terminal unit testing, adjusting, and balancing.

3.9 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Air terminal unit will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 233600

SECTION 233713.13 - AIR DIFFUSERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Air Diffusers.

B. Related Requirements:

1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers.
2. Section 233713.23 "Air Registers and Grilles" for adjustable-bar register and grilles, fixed-face registers and grilles, and linear bar grilles.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
b. Diffuser Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 AIR DIFFUSERS

A. Refer to Schedule on design drawings.

2.2 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers in accordance with ASHRAE 70.

PART 3 - EXECUTION

3.1 INSTALLATION OF AIR DIFFUSERS

A. Install diffusers level and plumb.

B. Ceiling-Mounted Outlets and Inlets: For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.2 ADJUSTING

A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713.13

SECTION 233713.23 - REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Registers.
2. Grilles.

B. Related Requirements:

1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to registers and grilles.
2. Section 233713.13 "Air Diffusers" for various types of air diffusers.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
b. Register and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.3 REGISTERS

A. Registers: Refer to Schedule on Design Drawings.

1.4 GRILLES

A. Grilles: Refer to Schedule on Design Drawings.

1.5 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate registers and grilles in accordance with ASHRAE 70.

PART 2 - EXECUTION

2.1 EXAMINATION

A. Examine areas where registers and grilles are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

2.2 INSTALLATION OF REGISTERS AND GRILLES

A. Install registers and grilles level and plumb.

B. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

2.3 ADJUSTING

A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713.23

SECTION 234100 - PARTICULATE AIR FILTRATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pleated panel filters.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide one complete set(s) of filters for each filter bank.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean, dry place.

B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.

D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.

1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remover coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.
3. Replace installed products damaged during construction.

PART 2 - PRODUCTS

A. ASHRAE Compliance:

1. Comply with applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality"; Section 5 - "Systems and Equipment"; and Section 7 - "Construction and Startup."
2. Comply with ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.

B. Comply with NFPA 90A and NFPA 90B.

2.2 PLEATED PANEL FILTERS

A. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters with holding frames.

B. Source Limitations: Obtain from single source from single manufacturer.

C. Capacities and Characteristics:

1. Minimum Efficiency Reporting Value: MERV 13, with "Composite Average Particle Size Efficiency, Percent in Size Range, Micrometers" according to ASHRAE 52.2.

D. Media: Interlaced glass or Cotton and synthetic fibers coated with nonflammable adhesive.

1. Separators shall be bonded to the media to maintain pleat configuration.
2. Welded-wire grid shall be on downstream side to maintain pleat.
3. Media shall be bonded to frame to prevent air bypass.
4. Support members on upstream and downstream sides to maintain pleat spacing.

E. Filter-Media Frame: Cardboard frame with perforated metal retainer sealed or bonded to the media.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF FILTERS

A. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.

B. Install filters in position to prevent passage of unfiltered air.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.

D. Coordinate filter installations with duct and air-handling-unit installations.

3.3 FIELD QUALITY CONTROL

A. Air filter will be considered defective if it does not pass inspections.

3.4 CLEANING

A. After completing system installation and testing, adjusting, and balancing of air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION 234100

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SECTION 236423.13 - AIR-COOLED SCROLL WATER CHILLERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes design, performance criteria, refrigerants, controls, and installation requirements for air-cooled rotary scroll packaged chillers.

1.02 REFERENCES

A. AHRI 550/590 - Standard for Water Chilling Packages using the Vapor Compression Cycle

B. AHRI 370 - Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment

C. ASHRAE 15 - Safety Code for Mechanical Refrigeration

D. ASHRAE 90.1 - Energy Efficient Design of New Buildings

E. UL 60335-2-40 - Central Cooling Air Conditioners

F. ASTM B117 - Standard Method of Salt Spray (Fog) Testing

G. ASTM A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

H. ASTM A525 - Zinc (Hot-Dip Galvanized) Coatings on Sheet Steel Products

I. ASTM D1654 - Evaluation of Painted or Coated Specimens, Subjected to Corrosive Environments

J. ANSI/AFBMA 9-1978 - Load Ratings and Fatigue Life for Ball Bearings.

K. ISO 9001

L. California Administrative Code - Title 24

1.03 SUBMITTALS

A. Submit dimensional plan and elevation view drawings, weights and loadings, required clearances, location and size of all field connections, electrical requirements and wiring diagrams.

B. Submit product data indicating rated capacities, accessories and any special data.

C. Submit manufacturer's installation instructions.

1.04 REGULATORY REQUIREMENTS

A. Comply with codes and standards specified.

B. Chiller must be built in an ISO 9001 classified facility.

1.05 VERIFICATION OF CAPACITY AND EFFICIENCY

A. All proposals for heat pump performance must include an AHRI approved selection method. Verification of date and version of computer program selection or catalog is available through AHRI.

B. Heat pump must be AHRI 550/590 certified in cooling mode

1.06 DELIVERY, HANDLING AND STORAGE

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting chillers.

B. Chiller shall be capable of withstanding -40ºF (-40ºC) to 158ºF (70ºC) storage temperatures for an indefinite period of time.

1.07 WARRANTY

A. Provide a full parts warranty for one year from start-up or 18 months from shipment, whichever occurs first.

B. Year 2-5 parts warranty whole unit

C. 1st year labor warranty whole unit

D. 2-5th year labor warranty whole unit

E. 1st year refrigerant warranty

F. 2-5th year refrigerant warranty

PART 2 - PRODUCTS

2.01 CHILLER DESCRIPTION

A. The contractor shall furnish and install air-cooled heat pump chiller with scroll compressors as shown as scheduled on the contract documents. The chillers shall be installed in accordance with this specification and perform at the specified conditions as scheduled.

2.02 CHILLER OPERATION

A. Heat pump shall be capable of operating in cooling mode from -4ºF to 125ºF (-20 to 51.7ºC). Heat pump should capable of operating in heating mode from 0ºF to 95ºF (-17.8 to 35ºC). Load temperature and capacities will vary.

B. Chiller shall be capable of starting up with 95ºF (35ºC) entering fluid temperature to the evaporator. Maximum water temperature that can be circulated with the Chiller not operating is 125ºF (52ºC)

C. Chiller shall provide evaporator freeze protection and low limit control to avoid low evaporator refrigerant temperature trip-outs during critical periods of chiller operation. Whenever this control is in effect, the controller shall indicate that the chiller is in adaptive limit. If the condition exists for more than 30 seconds, a limit warning alarm relay shall energize.

2.03 COMPRESSORS

A. Construct chiller using fully hermetic scroll type compressors with R454B optimized and dedicated scroll profile. Refrigerant shall have a GWP of less than 600.

B. Provide direct drive motor cooled by suction gas with only three major moving parts and a completely enclosed compression chamber which leads to increased efficiency.

C. Each compressor shall have Intermediate Discharge Valves (IDV) or variable volume ratio technology

D. Each compressor shall have overload protection internal to the compressor

E. Each compressor shall include: oil level sight glass and oil charging valve

F. Each compressor will have crankcase heaters installed and properly sized to minimize the amount of liquid refrigerant present in the oil sump during off cycles.

2.04 LOAD HEAT EXCHANGER

A. The evaporator shall be a high efficiency, brazed plate-to-plate type heat exchanger consisting of parallel plates. Braze plates shall be stainless steel with copper braze material.

B. The water side working pressure shall be rated at 150 psig (10.3 bar) and tested at 1.5 times maximum allowable water side working pressure.

C. The refrigerant side working pressure shall be rated at 650 psig (44.8 bar) and tested at 1.1 maximum allowable refrigerant side working pressure.

D. Heat pump must utilize a suction liquid heat exchanger in addition to load heat exchanger for optimized refrigerant circuit operation

E. Insulate the evaporator with a minimum of 1.25 inch (K=0.28) UV rated insulation. If the insulation is field installed, the additional money to cover material and installation costs in the field should be included in the bid.

F. Evaporator heaters shall be factory installed and shall protect chiller down to -20ºF (-29ºC). Contractor shall wire separate power to energize heat tape and protect evaporator while chiller is disconnected from the main power.

G. Provide water drain connection, vent and fittings. Factory installed leaving water temperature control and low temperature cutout sensors.

H. Water connections shall be grooved pipe.

I. Proof of flow shall be provided by the equipment manufacturer, mechanically installed and electrically wired, at the factory of origin.

2.05 FANS

A. Low sound fans shall be balanced and direct driven.

B. All condenser fan TEAO motors have permanently lubricated ball bearings and internal overload protection.

C. All condenser fans are electrically commutated motors to provide variable speed for optimized efficiency and lower part load sound.

2.06 COILS

A. Construct condenser coils of aluminum fins mechanically bonded to internally finned copper tube. The condenser coils shall have an integral subcooling circuit and shall be designed for 650 psig or higher working pressure. Leak tested at 650 psig.

B. Condenser coils shall be transverse design. If coils are not transverse design, provide coil protection for shipping.

2.07 ENCLOSURES/CHILLER CONSTRUCTION

A. Unit panels, structural elements and control boxes are constructed of galvanized steel and mounted on a bolted galvanized steel base. Unit panels, control boxes and the structural base are finished with a baked on powder paint.

B. Control panel doors shall have door stays.

C. Mount starters and Terminal Blocks in a UL 60335-2-40 rated weatherproof panel provided with full opening access doors. If a circuit breaker is chosen, it should be a lockable, through-the-door type with an operating handle and clearly visible from outside of chiller indicating if power is on or off.

D. The coating or paint system shall withstand 500 hours in a salt-spray fog test in accordance with ASTM B117.

2.08 ELECTRICAL

A. The starter shall be across-the-line configuration, factory-mounted and fully pre-wired to the compressor motor(s) and control panel.

B. Unit shall have a single point power connection.

C. Power line connection type shall be standard with a terminal block.

D. A control power transformer shall be factory-installed and factory-wired to provide unit control power.

E. Unit wiring shall run in liquid-tight conduit.

F. High short circuit current rating (SCCR) of 10kA.

G. Customer wired 15 amp, 115-volt GFCI convenience outlet shall be factory mounted on the exterior of the control panel.

2.09 REFRIGERANT CIRCUIT

A. All chillers shall have 2 refrigeration circuits, each with two or three (manifolded) compressor on each circuit.

B. Provide for refrigerant circuit:
1. Liquid line shutoff valve
2. Discharge service valve
3. Replaceable Core Filter Drier
4. Liquid line sight glass.
5. Dual electronic expansion valves on each circuit (sized for maximum operating pressure) - One dedicated for cooling mode and one dedicated for heating mode.
6. Electronic expansion valves installed with check valves
7. Charging valve
8. Reversing valve
9. Suction line heat exchnager with refrigerant control valves.

C. Full operating charge of R454B and oil.

2.10 CONTROLS

A. A color, touch sensitive liquid crystal display (LCD) shall be unit mounted and a minimum of 7" diagonal.

B. Display shall consist of a menu driven interface with easy touch screen navigation to organized sub-system reports for compressor and evaporator information as well as associated diagnostics.

C. The chiller control panel shall provide password protection of all setpoints with configurable user settings for each user.

D. The controller shall have the ability to display all primary sub-system operational parameters on dedicated trending graphs. The operator must be able to create up to 6 additional custom trend graphs, choosing up to 10 unique parameters for each graph to trend log data parameters simultaneously over an adjustable period and frequency polling.

E. Chilled water temperature control shall be microprocessor-based, proportional and integral controller to show water and refrigerant temperature, refrigerant pressure, and diagnostics. This microprocessor-based controller is to be supplied with each chiller by the chiller manufacturer.

F. The front of the chiller control panel shall display the following in clear language, without the use of codes, look-up tables, or gauges:
1. Run time.
2. Number of starts.
3. Current chiller operating mode.
4. Chilled water set point and set point source.
5. Demand current limit set point and set point source.

6. Entering and leaving evaporator water temperatures.
7. Saturated evaporator and condenser refrigerant temperatures.
8. Evaporator and condenser refrigerant pressure.
9. Phase reversal/unbalance/single phasing and over/under voltage protection.
10. Low chilled water temperature protection.
11. High and low refrigerant pressure protection.
12. Load limit thermostat to limit compressor loading on high return water temperature.
13. Condenser fan sequencing to automatically cycle fans in response to load, expansion valve pressure, condenser pressure, and differential pressure to optimize chiller efficiency.
14. Display diagnostics.
15. Compressors: Status (on/off), anti-short cycle timer, and automatic compressor lead-lag.

G. Weatherproof control panel shall be mounted on chiller, containing starters, power and control wiring, factory wired with terminal block power connection. Provide primary and secondary fused control power transformer.

H. The chiller controller shall utilize a microprocessor that will automatically take action to prevent chiller shutdown due to abnormal operating conditions associated with: evaporator refrigerant temperature, high condensing pressure and motor current overload.

I. Provide the following safety controls with indicating lights or diagnostic readouts:
1. Low chilled water temperature protection.
2. High refrigerant pressure.
3. Loss of chilled water flow.
4. Contact for remote emergency shutdown.
5. Motor current overload.
6. Phase reversal/unbalance/single phasing.
7. Over/under voltage.
8. Failure of water temperature sensor used by controller.
9. Compressor status (on or off).

J. Provide the following operating controls:
1. A variable compressor staffing method to control capacity in order to maintain leaving chilled water temperature based on PI algorithms. Five minute solid state anti-recycle timer to prevent compressor from short cycling. Compressor minimum stop-to-start time limit shall be 2 minutes. If a greater than 5 minute start-to-start, or greater than 2 minute stop-to-start timer is included.
2. Chilled water pump output relay that closes when the chiller is given a signal to start.
3. Load limit thermostat to limit compressor loading on high return water temperature to prevent nuisance trips.
4. High ambient unloader pressure controller that unloads compressors to keep head pressure under control and help prevent high pressure nuisance trip outs on days when outside ambient is above design.
5. Low ambient lockout control with adjustable setpoint.
6. Condenser fan sequencing which adjusts the speed of all fans automatically in response to ambient, condensing pressure and expansion valve pressure differential thereby optimizing chiller efficiency.

K. Provide user interface on the front of the panel. If display is on the inside of the panel, then a control display access door shall be provided to allow access to the display without removal of panels. Provide user interface with a minimum of the following features:
1. Leaving chilled water setpoint adjustment from the front panel touchscreen display.
2. Entering and leaving chilled water temperature output
3. Pressure output of condenser
4. Pressure output of evaporator

5. Ambient temperature output
6. Demand limit setpoint adjustment from the front panel touchscreen display.

L. The chiller control panel shall provide leaving chilled water temperature reset based upon return water temperature.

M. Advanced Defrost Logic including Loss of Flow Logic during Defrost changeover and Warm-up Cycle

N. Service Pump Down Control

O. Active Hot Water Reset Program

P. Configurable Users

Q. Multiple Languages Selectable

R. Metric Conversions

S. Digital Communications to BAS system shall consist of a BACnet MS/TP interface via a single twisted pair wiring.

2.11 SOUND

A. Acoustics: Manufacturer must provide both sound power and sound pressure data in decibels, per AHRI 370. A-weighted sound pressure at 30 feet should be provided at 100%, 75%, 50% and 25% load points to identify the full operational noise envelope.

B. If manufacturer cannot meet the noise levels, sound attenuation devices and/or barrier walls must be installed to meet this performance level.

2.12 OPTIONS AND ACCESSORIES

A. Chiller shall have full architectural louvers panels.

B. Chiller shall ship with elastomeric Isolators

PART 3 - EXECUTION

3.01 EXAMINATION

A. Before water chiller installation, examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, controls, and electrical connections to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.

1. Water chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping, controls, and electrical connections.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 WATER CHILLER INSTALLATION

A. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures with actual equipment provided.

B. Install water chillers on support structure indicated.

C. Equipment Mounting:

1. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

D. Maintain manufacturers recommended clearances for service and maintenance.

E. Maintain clearances required by governing code.

F. Chiller manufacturer's factory-trained service personnel shall charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.

G. Install separate devices furnished by manufacturer and non-factory installed.

1. Chillers shipped in multiple major assemblies shall be field assembled by chiller manufacturer's factory-trained service personnel.

3.03 PIPING CONNECTIONS

A. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to chillers, allow space for service and maintenance.

C. Evaporator Fluid Connections:

1. Connect to evaporator inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage.
2. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with pressure gage, flow meter, and drain connection with valve.
3. Make connections to water chiller with a flange or mechanical coupling.

D. Connect each drain connection with a drain valve, full size of drain connection.

E. Connect each chiller vent connection with a manual vent, full size of vent connection.

3.04 ELECTRICAL POWER CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Provide nameplate for each electrical connection indicating electrical equipment designation and circuit number feeding connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high. Locate nameplate where easily visible.

3.05 CONTROLS CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between chillers and other equipment to interlock operation as required to provide a complete and functioning system.

C. Connect control wiring between chiller control interface and DDC system for remote monitoring and control of chillers. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

D. Provide nameplate on face of chiller control panel indicating control equipment designation serving chiller and the I/O point designation for each control connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high.

3.06 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
2. Verify that pumps are installed and functional.
3. Verify that thermometers and gages are installed.
4. Operate water chiller for run-in period.
5. Check bearing lubrication and oil levels.
6. Verify that refrigerant pressure relief device for chillers installed indoors is vented outside.
7. Verify proper motor rotation.
8. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.
9. Verify and record performance of water flow and low-temperature interlocks.
10. Verify and record performance of water chiller protection devices.
11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

D. Visually inspect chiller for damage before starting. Repair or replace damaged components, including insulation. Do not start chiller until damage that is detrimental to operation has been corrected.

E. Prepare a written startup report that records results of tests and inspections.

3.07 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water chillers.

1. Instructor shall be factory trained and certified.
2. Provide not less than eight hours of training.
3. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
4. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
5. Obtain Owner sign-off that training is complete.
6. Owner training shall be held at Project site.

END OF SECTION 236423.13

SECTION 236433.13 - AIR-COOLED MODULAR CHILLER

PART 1 - GENERAL

1.01 WORK INCLUDED

A. The air-cooled modular chiller system shall consist of individual chiller modules that are assembled on site. Each chiller module shall be completely factory wired, and tested prior to shipment. Each module shall include a compressor, evaporator, air cooled condenser, and controls. Controls shall be designed on a distributed primary control system that allows the primary microprocessor to operate remaining secondary modules in the event of a malfunction of any secondary controller. The controls shall also be designed to allow each individual secondary microprocessor to operate on its own temperature sensor if there is a failure of the primary microprocessor.

1.02 QUALITY ASSURANCE

A. Unit shall be constructed in accordance with the UL 60335 2-40 and NEC standards and be UL or ETL listed.

B. Unit shall be rated and tested in accordance with ARI 550/590 – Standard for Water Chilling Packages.

C. Unit shall meet the safety standards of ANSI/ASHRAE 15 – Safety Standard for Refrigerated Systems.

1.03 SUBMITTALS

A. Submit complete drawings including cabinet dimensional details and anchor point locations, required clearances, location and sizes of field connections, performance data, electrical wiring diagrams, dry and operation weights, and all required electrical data.

B. Submit manufacturer’s installation instructions, including any remote panel installation instructions.

C. Operating and Maintenance manuals: provide two copies of current commercial manuals.

1.04 REGULATORY REQUIREMENTS

A. Comply with codes and standards specified.

1.05 VERIFICATION OF CAPACITY AND EFFICIENCY

A. All proposals for chiller performance must include an AHRI approved selection method. Verification of date and version of computer program selection or catalog is available through AHRI.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. Protect units on site from physical damage after unloading.

1.07 WARRANTY

A. Provide a full parts warranty for one year.

B. Provide a refrigerant warranty for one year.

C. Provide a five year compressor parts warranty.

D. Labor warranty by OEM - 5 year

E. Refrigerant warranty by OEM - 5 year

PART 2 - PRODUCTS

2.01 CHILLER

A. Trane model AMC Heat Recovery

2.02 CHILLER DESCRIPTION

A. Each module shall be assembled on a powder coated, formed galvanized sheet metal frame and panels. The module shall be shipped individually and assembled on site. Each module shall be fully charged with refrigerant and factory tested for capacity and controller functions prior to shipment.

B. System shall use R-454B refrigerant

2.03 FRAME

A. Frame shall be constructed of white powder coated formed galvanized sheet metal.

B. The modules shall ship on a single skid, assembled at the factory.

2.04 CABINET

A. White powder coated formed galvanized sheet metal panels that shall be easily removable for servicing via stainless steel fasteners and retaining clips.

B. Power shall be routed through a single electrical distribution panel. Chiller system must be built for single point power supply connection. The power distribution panel shall incorporate a

circuit breaker for overload protection for each module. Electrical supply to each module shall consist of flexible conduit. No electrical connection to a module shall carry the load of more than that module. The electrical supply connections for each module shall be factory assembled and shipped with each module for field connection into the power distribution panel.

2.05 COMPRESSORS

A. Hermetically sealed, scroll compressor on each refrigeration circuit each with rotalock connections, oil level sight glass, suction gas-cooled motor with solid-state sensors in the windings for overload protection, and circuit breaker protection. There shall be two independent compressors and refrigerant circuits per module. Compressors shall be mounted to the heavy gauge steel frame with rubber-in-shear vibration isolators.

2.06 EVAPORATOR

A. Dual circuit, brazed plate heat exchanger on each module constructed of 316 stainless steel plates and copper brazing. The fluid connections to each heat exchanger shall use roll grooved couplings for service convenience and ease of installation. Each heat exchanger shall be insulated with ¾" closed cell insulation. The maximum working pressure shall be 650 psi. Piping fluid velocity shall not exceed 10 fps at any point in the system.

B. Evap and wetted components - The evaporator and all fluid filled piping and components shall be protected against freezing by installing self-regulating heat trace cable. The heat trace cable shall be UL listed and CSA certified and shall consist of two 16 AWG nickel-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature along its length. The heat trace cable shall have a heat output of 8 watts per ft. The cable shall be powered by 120/60/1 circuit provided by others.

2.07 ISOLATION VALVES

A. Each evaporator branch line shall include a manual inlet and an electronic discharge butterfly valve that allows system flow to each active module to match the cooling requirements of the system. By isolating individual modules that are not operating, this allows the hydronic system to have variable primary flow. The valves shall be the slow opening type to minimize the sudden change in flow to the previously active modules. The valves shall have a minimum opening cycle time of 30 seconds between the fully closed and open position and shall have roll grooved connections. The valves shall have a minimum close off pressure of not less than 75 psi and shall be rated for a maximum working pressure of 250 psi. The actuators shall be rated for 24 VAC

2.08 FILTERS

A. A 40-mesh industrial grade filter strainer shall be factory installed between the header system and each brazed plate heat exchanger. The strainer shall be serviceable by isolation valves that permit each strainer to be removed and cleaned without shutting down fluid flow or power to the entire system and allowing the remaining modules to continue to operate. In-line strainers that require complete system shutdown for service and isolation are not acceptable.

2.09 CONDENSER

A. Epoxy Coated Coil - Aluminum fins mechanically bonded to copper tubes with integral subcooling circuits. Fin spacing shall not exceed 16 fins per inch. The coils shall be sized to provide full heat of rejection at jobsite elevation above sea level, at a maximum 25 degree F temperature difference between the condensing temperature and ambient air temperature. The coils shall be factory tested to a minimum of 600 psig. Coil will be coated with a flexible epoxy polymer.

B. The condenser controls shall include pressure actuated fan cycling controls on each condenser fan motor to maintain proper head pressure control in ambient temperatures down to 0 degree F

C. The modular heat recovery chiller system is equipped with a brazed plate condenser in each module. Module will have a thermal dispersion flow switch plus valves and controls for heat recovery operation.

D. The heat recovery condenser and all fluid filled piping and components shall be protected against freezing by installing self-regulating heat trace cable. The heat trace cable shall be UL listed and CSA certified and shall consist of two 16 AWG nickel-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature along its length. The heat trace cable shall have a heat output of 6 watts per ft. The cable shall be powered by 120/60/1 circuit provided by others.

2.10 FANS

A. The condenser fan motors shall be maintenance free, quiet, highly efficient Electronically Commutated Motors (ECM) with energy reduction capabilities of up to 35%. These variable speed fan assemblies shall vary fan motor RPM to maintain the refrigeration pressure of the chiller modules.

B. Each fan contains a diffuser that shall improve efficiency and reduce the noise of the ECM fans. By increasing the fan efficiency, the motor speed can be reduced thereby lowering the sound pressure.

2.11 LIQUID PIPING

A. The chilled fluid piping shall be Schedule 40 steel and be insulated using closed cell pipe insulation to prevent condensation and to retain temperature. The pump module shall connect to the adjacent modules using roll-grooved steel couplings and neoprene gaskets. Any type of module-to-module pipe connection external to the modules is unacceptable.

2.12 REFRIGERANT PIPING AND ACCESSORIES

A. Refrigerant piping shall be Type K seamless copper, insulated with closed cell pipe insulation on the suction lines.

B. Each refrigerant circuit shall include compressor rotalock service valves, solenoid valves for compressor pumpdown, and Schrader service valves in the suction, discharge, and liquid lines, liquid line sight glass with moisture indicator and a filter dryer.

2.13 CONTROLS

A. The primary chiller module shall incorporate the primary microprocessor controller. The primary microprocessor shall communicate with the remaining secondary microprocessors in each module via a local network communications protocol. The primary microprocessor shall include a phase monitor to protect against low voltage, phase unbalance, phase loss, and phase reversal conditions. The primary controller shall read all analog and fault port values from all secondary module controllers and shall pass these values to the Building Automation System via BACnet, Modbus or Lonworks protocols. Each chiller control system shall include operational switches for each compressor; high- and low-pressure transmitters to provide indication of refrigeration pressures in each circuit; high and low refrigeration pressure alarms including shutting shut down the responsible compressor(s); anti-short cycling compressor timers; minimum compressor run timers; connection to Building Automation System (if required).

2.14 MICROPROCESSOR

A. The microprocessor shall provide the following minimum functions and alarms:
   1. Adjustable fluid temperature set point
   2. Multiple stage compressor control, including compressor rotation to provide compressor usage and wear.
   3. High and low fluid temperature alarm set points
   4. Water inlet and outlet temperature
   5. Suction and discharge refrigeration pressures
   6. Compressor run status
   7. Current alarm status
   8. Demand load
   9. Compressor run hours
   10. Alarm logging with minimum of previously 100 logged alarms with time and date of each occurrence
   11. Remote start stop input
   12. Dry contact for general alarm

2.15 INTERFACE PANEL

A. An operator 7” touch screen interface panel with graphical display shall be installed on the master module to allow chiller operation monitoring, adjustment of user set points, and alarm monitoring.

2.16 BMS INTERFACE

A. The primary microprocessor controller shall provide communications to the building management system via RS-485 serial communications card. The system shall interface with the BMS via BACnet MS/TP or BACnet IP/Ethernet, MODBUS or LonWorks. All functions of the control system shall be accessible from the BMS including:
   1. Chiller enable/disable
   2. Compressor run status
   3. System evaporator and condenser temperatures
   4. Adjustment of all system set points
   5. Review and resetting of all non-active faults
   6. Interrogation and display of all sensor faults

PART 3 - EXECUTION

3.01 EXAMINATION

A. Before water chiller installation, examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, controls, and electrical connections to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.

1. Water chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping, controls, and electrical connections.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 WATER CHILLER INSTALLATION

A. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures with actual equipment provided.

B. Install water chillers on support structure indicated.

C. Equipment Mounting:

1. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

D. Maintain manufacturers recommended clearances for service and maintenance.

E. Maintain clearances required by governing code.

F. Chiller manufacturer's factory-trained service personnel shall charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.

G. Install separate devices furnished by manufacturer and non-factory installed.

1. Chillers shipped in multiple major assemblies shall be field assembled by chiller manufacturer's factory-trained service personnel.

3.03 PIPING CONNECTIONS

A. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to chillers, allow space for service and maintenance.

C. Evaporator Fluid Connections:

1. Connect to evaporator inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage.
2. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with pressure gage, flow meter, and drain connection with valve.
3. Make connections to water chiller with a flange or mechanical coupling.

D. Heat Recovery Condenser Fluid Connections:

1. Connect to condenser inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage.
2. Connect to condenser outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with pressure gage, flow meter, and drain connection with valve.
3. Make connections to water chiller with a flange or mechanical coupling.

E. Connect each drain connection with a drain valve, full size of drain connection.

F. Connect each chiller vent connection with a manual vent, full size of vent connection.

3.04 ELECTRICAL POWER CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Provide nameplate for each electrical connection indicating electrical equipment designation and circuit number feeding connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high. Locate nameplate where easily visible.

3.05 CONTROLS CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between chillers and other equipment to interlock operation as required to provide a complete and functioning system.

C. Connect control wiring between chiller control interface and DDC system for remote monitoring and control of chillers. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

D. Provide nameplate on face of chiller control panel indicating control equipment designation serving chiller and the I/O point designation for each control connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high.

3.06 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
2. Verify that pumps are installed and functional.

3. Verify that thermometers and gages are installed.
4. Operate water chiller for run-in period.
5. Check bearing lubrication and oil levels.
6. Verify that refrigerant pressure relief device for chillers installed indoors is vented outside.
7. Verify proper motor rotation.
8. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.
9. Verify and record performance of chilled- and heat recovery condenser-water flow and low-temperature interlocks.
10. Verify and record performance of water chiller protection devices.
11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

D. Visually inspect chiller for damage before starting. Repair or replace damaged components, including insulation. Do not start chiller until damage that is detrimental to operation has been corrected.

E. Prepare a written startup report that records results of tests and inspections.

3.07 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water chillers.

1. Instructor shall be factory trained and certified.
2. Provide not less than eight hours of training.
3. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
4. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
5. Obtain Owner sign-off that training is complete.
6. Owner training shall be held at Project site.

END OF SECTION 236433.13

SECTION 237343.19 - OUTDOOR, CUSTOM AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Outdoor, custom air-handling units.

B. Related Requirements:

1. Section 237313.19 "Indoor, Custom Air-Handling Units."

1.2 ACTION SUBMITTALS

A. Product Data: For each outdoor, custom air-handling unit.

1. Product information organized to show compliance with each performance requirement of "Performance Requirements" article.
2. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
3. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
4. Include unit dimensions and weight.
5. Include cabinet material, metal thickness, finishes, insulation, and accessories.
6. Fans:
    a. Include certified fan-performance curves with system operating conditions indicated. For fans operating at variable speeds include curves in 10 percent speed increments starting at design speed down to minimum speed.
    b. Include fan-sound power ratings in all eight octave bands. Include inlet or outlet sound power levels to coincide with sound requirements indicated on Drawings.
    c. Include fan construction and accessories. Submit sufficient information to show product compliance with requirements indicated.
    d. Include dimensions and weight.
    e. Include motor ratings, electrical characteristics, and motor accessories.
7. Vibration isolation product data with performance ratings. Uniquely identify and include information for each different isolator type and indicate for each air-handling unit where each isolator type is being used.
8. Include certified coil-performance ratings with system operating conditions indicated. Product data to include: dimensions, dry and operating weight, volume of fluid contained, materials of construction, and performance ratings with system operating conditions indicated.
9. Casing insulation product data and performance ratings.
10. Access door and access panel product data and performance ratings.
11. Roofing product data and performance ratings.
12. Louver product data and performance ratings.
13. Paint product data and performance ratings.
14. Electrical product data and performance ratings.

15. Metal grating product data and performance ratings.
16. Dampers product data, including housings, linkages, and operators with performance ratings.
17. Filters product data with performance characteristics.
18. Roof curbs product data.

B. Shop Drawings: For each type and configuration of indoor, custom air-handling unit.

1. Prepared by manufacturer's factory employees with review and sign-off by those individuals responsible for manufacturing the air-handling units.
2. Include plans, elevations, sections, and attachment details.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, methods of field assembly, components, and location and size of each field connection.
4. Detail fabrication and assembly of indoor, custom air-handling units, as well as procedures and diagrams.
5. Indicate details of construction with materials description including applicable specified standards and material grades in sufficient detail for reviewers to evaluate point by point compliance with requirements indicated for each air-handling unit.
6. Use actual dimensions of internal equipment in preparing Shop Drawings. Identify mechanical equipment shown on Shop Drawings with equipment designations on Drawings.
7. Thickness and finish of all casing materials with cross references indicated where each is used. Uniquely identify and include information for each different casing construction.
8. Details for each unique casing joint and reinforcing. Indicate wall joints, wall to floor joints, wall to roof joints, floor joints, and roof joints.
9. Roofing details.
10. Assembly details of base and casing for units consisting of multiple sections requiring field assembly.
11. Sizes and dimensioned locations of field connections for ductwork, piping, electrical, and controls.
12. Base and casing penetration and sealing details for factory-installed conduit.
13. Base and casing penetration and sealing details for factory-installed piping including coils.
14. Details of casing connections to field-installed ductwork.
15. Size, shape and layout of base members including localized support of internal components.
16. Base materials, thickness, finishes, lifting provisions, and mounting requirements. Uniquely identify and include information for each different base construction. Clearly indicate for each air-handling unit.
17. Recommended points of field attachment with dimensioned locations.
18. Size and location of each access door, including clearing opening size, with door swing indicated.
19. Size and location of each access panel with service equipment superimposed to show relationship of panel to internal equipment.
20. Drain pans and associated piping, with sizes and locations dimensioned, including relationship to internal equipment.
21. Coil framework and support including enlarged details showing framework attachment to air-handling unit base, coil attachment to framework, and means for individual coil removal.
22. Mounting details of all internal components, such as fans, filters, and dampers.
23. Location of receptacles, service lights, and switches.
24. Location of motor controllers and disconnect switches.
25. Size and location of junction boxes used for interface with field electrical power.

26. Point-to-point electrical power wiring diagrams including wire size, conduit size, motor controllers sizes, switch types and ratings, receptacle types and ratings, service light fixture types and ratings.
27. Point-to-point control wiring diagrams including cable types and sizes, conduit sizes, and connected control devices.
28. Control panel drawings drawn to scale showing detailed internal layout.
29. Plans, sections and isometric reviews of hydronic piping systems showing pipe, fittings, flanges, unions, valves, vents, strainers, accessories, specialties and insulation.
30. Indicate code, operating, and maintenance clearances drawn to scale using dashed lines.
31. Indicate weights of internal components, weight of each separately shipped section, and air-handling unit total weight.

C. Comparison Schedule:

1. Submit a schedule to indicate performance of equipment scheduled on Drawings directly compared to performance of submitted equipment.
2. Clearly identify each line in schedule to indicate "Scheduled" where indicating performance scheduled on Drawings and "Submitted" where indicating performance of submitted equipment.
3. Organize schedule to first indicate performance scheduled on Drawings on one line followed by line directly below that indicates performance of submitted equipment.
4. Comparison schedule shall follow arrangement and organization of scheduled information indicated on Drawings.
5. Submitted equipment shall have a value for each scheduled value indicated.

D. Delegated Design Submittals: For vibration isolation indicated to comply with performance requirements and design criteria, including analysis data.

1.3 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

B. Startup service reports.

C. Field quality-control reports.

D. Sample Warranty: For manufacturer's warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Panel Filters: Two set(s) for each air-handling unit.
2. Access Door Gaskets: One set(s) for each unique access door.

B. Tool Kit: Manufacturer to provide a tool kit including special tools required for air-handling unit service. See "Accessories" Article for additional requirements.

1.6 COORDINATION

A. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

1.7 DELIVERY, STORAGE, HANDLING

A. Deliver air-handling units with factory-installed shipping skids and lifting lugs; pack small components in factory-fabricated protective containers. Cover units with heat-shrinkable plastic sheeting suitable for shipping from point of manufacture to Project.

B. Handle air-handling units carefully to avoid damage to components, casing, and finish. Do not install damaged components; replace and return damaged components to air-handling unit manufacturer.

C. Store air-handling units in a clean dry place and protect them from weather and construction activities.

D. Keep air-handling units fully covered and protected during construction. Remove dirt and debris and clean units to a factory-cleaned condition.

E. Comply with manufacturer's written rigging and installation instructions for unloading air-handling units and moving them to their final locations.

F. For air-handling units equipped with key locks on access doors, keep doors locked during construction.

1. If access is required within air-handling units, only open the doors to sections that require access and lock doors at the end of each workday.
2. Protect inside of air-handling units from damage and keep inside of units as clean as the factory-cleaned condition.
3. Report observed abuse to Architect for immediate corrective action.

1.8 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of air-handling units that fails in materials or workmanship within specified warranty period.

1. Warranty Period: One year(s) from date of Substantial Completion.

B. Extended warranties include, but are not limited to, the following:

1. Complete Air-Handling Unit: Five years from date of Substantial Completion for entire air-handling unit and longer where indicated for individual components.
2. Air-Handling Unit Casing: Ten years from date of Substantial Completion.
3. Air-Handling Unit Roofing: Ten years from date of Substantial Completion.
4. Motors: Five years from date of Substantial Completion

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handing units and components.

C. Casing Structural Performance:

1. Floor: Capable of withstanding positive/negative 8 inches wg of internal static pressure, without exceeding a deflection of L/360 of span.
2. Walls and Roof: Capable of withstanding positive/negative 8 inches wg of internal static pressure, without exceeding a midpoint deflection of L/200 of span.

D. Casing Leakage Performance: Comply with more stringent of the following requirements:

1. ASHRAE 111, Class 3 leakage or better at plus or minus 8 inches wg.
2. Not more than 0.5 percent of the total unit airflow at 8 inches wg.

E. Casing Thermal Performance:

1. Surface Condensation: Air-handling manufacturer shall evaluate potential for condensation and design and manufacture entire unit casing to prevent condensation at most extreme operating conditions encountered.
2. Thermal Break: Incorporate a thermal break at each through metal path to prevent condensation from occurring on interior and exterior of casing.
3. U-Value: Overall U-value or equivalent R-value of casing shall not exceed governing codes and ASHRAE/IES 90.1 while considering the effects of metal-to-metal contact and thermal bridging in calculations.

F. Air Tunnel Aerodynamic Performance: Position air-handling unit internal components and transition between internal components to maintain uniform airflow; minimize sound levels and energy consumption. Use methods indicated and other means to ensure compliance.

1. Use turning vanes if necessary to direct the air path.

    a. Design, manufacture, and install vanes in accordance with applicable requirements in ASHRAE and SMACNA guidelines, handbooks, and standards.
    b. Install vanes firmly in place so that no vane movement occurs at worst-case airflow capacity possible.

2. Use fan inlet and discharge transitions and other devices to maximize system regain and minimize airborne sound levels.
3. Center system components such as coils, fans, and filters, vertically and horizontally, in the airstream.
4. Maintain spacing between components such that airflow patterns to adjacent components are as uniform as possible and that component "dead spots" or "jetted areas" are avoided.
5. Design and install internal structural supports, piping, and conduit that do not block airflow and impede performance of coils, fans, filters, and other unit components, and service space clearances.

G. Casing Acoustical Performance:

H. Durability Performance: Design and manufacture air-handling units with underlying requirement to provide a highly durable piece of equipment.

1. Unit Life Expectancy: 25 years.
2. Supporting Documentation: Submit documentation showing proposed products to consider and include design features, components, and materials to satisfy requirement.

I. Extreme Operating Conditions:

1. Corrosive Environments: Air-handling unit manufacturer shall evaluate the quality and potential corrosiveness of air passing through air-handling units and propose additional protective finishes and better-quality materials of a heavier thickness if required to comply with requirements indicated.

    a. Unless otherwise indicated, air-handling units for HVAC applications may use up to 100 percent of outdoor air or a mix of outdoor air with return air from habitable areas served. Projects located in coastal and industrial areas may require added protection.

2. Humidity and Temperatures: Materials and components of air-handling units shall be suitable for use in low and high humidity and temperature extremes when operating under normal and abnormal conditions without permanent degradation or loss in material performance.

J. Outdoor Environment:

1. Air-handling units specially designed to withstand effects of wind, rain, ice, snow, seismic, air quality, sun, and other influences associated with outdoor installations.
2. Comply with requirements of air-handling unit and governing codes.

K. Safety:

1. Comply with OSHA regulations.
2. Exposed sharp edges and corners of metal shall be protected or rounded to prevent injury to personnel not wearing gloves.
3. Cover exposed ends of screws with plastic or metal covers to prevent injury to personnel coming in contact with screws.

L. Serviceability:

1. Hoisting Provisions: Fans and motors weighing more than 200 lb shall have full-length hoist rails mounted over the equipment to facilitate service, removal, and replacement.
2. Mounting Location: Install internal components in readily accessible locations to facilitate ease of service and replacement.
3. Service Access:

    a. Internal components shall be serviceable through access sections with doors indicated on Drawings.
    b. Internal components shall be removable and replaceable through access doors or panels.
    c. Review requirements for access doors and panels indicated and recommend additional access doors and panels if required for uninhabited service, removal, and replacement of components.

4. Tripping Hazards: Floors in accessible sections of air-handling unit shall be free of standing seams, reinforcing, supports, or section splits located in the walking path that is capable of causing a tripping hazard. Locate section splits immediately adjacent to internal walls.

M. Quality: Type and thickness of materials indicated are the minimum acceptable. Provide better-quality materials of a heavier thickness if required to comply with performance requirements indicated.

1. If manufacturer's standard construction exceeds requirements indicated, use manufacturer's standard construction.
2. If manufacturer's standard construction does not comply with requirements indicated, modify manufacturer's standard construction to comply with requirements.

N. Vibration Performance: Air-handling unit manufacturer shall evaluate vibration of internal components installed inside of air-handling units and include internal vibration isolation required to limit the vibration transmitted to the building at a low enough level that vibration is not perceived by building occupants.

2.2 CAPACITIES AND CHARACTERISTICS

A. See equipment schedules on Drawings.

2.3 SOURCE LIMITATIONS

A. Source all outdoor custom air-handling units from same manufacturer.

B. Like components furnished with air-handling units shall be from same manufacturer.

2.4 OUTDOOR, CUSTOM AIR-HANDLING UNITS

A. See equipment schedules on Drawings.

2.5 SOURCE QUALITY CONTROL

A. AHRI Compliance:

1. AHRI 260 (I-P): Air-handling unit sound ratings shall be in accordance with AHRI 260 (I-P), "Sound Rating of Ducted Air Moving and Conditioning Equipment."
2. AHRI 410: Air-handling unit coils shall be rated in accordance with AHRI 410 and shall be listed by AHRI and labeled in accordance with AHRI.

B. AMCA Compliance:

1. AMCA 201: Air-handling unit manufacturer shall evaluate fan's performance within the air-handling unit in accordance with AMCA 201, "Fans and Systems" and account for conditions within the air-handling unit that could be detrimental to fan's performance by adjusting the fan performance indicated on Drawings.
2. AMCA 205 Certification: Air-handling unit fan's fan efficiency grade (FEG) shall be rated in accordance with AMCA 205, "Energy Efficiency Classifications for Fans" and shall bear the AMCA-certified fan efficiency grade seal.

3. AMCA 210 Certification: Air-handling unit fan's air performance shall be rated in accordance with AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating" and shall bear the AMCA-certified air ratings seal.
4. AMCA 300: Air-handling unit fan's sound performance shall be rated in accordance with AMCA 300, "Reverberant Room Method for Sound Testing of Fans."
5. AMCA 301 Certification: Air-handling unit fans sound performance shall be rated in accordance with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data" and shall bear the AMCA-certified sound ratings seal.
6. AMCA 500-D: Air-handling unit damper's performance shall be rated in accordance with AMCA 500-D, "Laboratory Methods of Testing Dampers for Rating" and shall bear the AMCA-certified air ratings seal.

C. NFPA Compliance:

1. NFPA 70: Electrical components, devices, and accessories shall be listed and labeled by a qualified testing agency, and marked for intended location and application.
2. NFPA 90A: Design, fabrication, and installation of air-handling units and components shall comply with NFPA 90A.

D. UL Compliance:

1. UL 1995 Certification: Where indicated, air-handling unit components shall be NRTL listed and labeled in accordance with UL 1995, "Standard for Safety Heating and Cooling Equipment."

2.6 SOURCE QUALITY CONTROL - INDEPENDENT LABORATORY TESTING

A. General:

1. Project-specific testing by an independent laboratory is not required if air-handling unit manufacturer has written independent laboratory test results of past tests performed on same casing construction proposed for use on this Project.
2. If Project-specific testing is required, testing shall be performed in ample time to include test reports with submittals and before manufacturing of air-handling units. Include sufficient lead time for unit delivery, installation, and testing required by construction schedule.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine air-handling units before installation. Reject units with physical damage, and air-handling unit components that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for the following before installation of air-handling units:

1. Structural substrate mounting and anchorage to verify actual sizes, types, and locations.
2. Piping systems to verify actual sizes, types, and locations of connections.
3. Ductwork and plenums to verify actual sizes, types, and locations of connections.

4. Electrical services and controls to verify actual sizes, types, and locations of connections.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF OUTDOOR, CUSTOM AIR-HANDLING UNITS

A. Equipment Mounting: Install air-handling units at locations indicated on Drawings. Unless, otherwise indicated on Drawings, install air-handling units on concrete roof.

1. Install air-handling units on curbs following air-handling unit manufacturer's written procedures.

    a. Install gaskets before setting air-handling units on curbs.
    b. Secure air-handling units to curbs using stainless steel fasteners.
    c. Install curb and fasten to structure.
    d. Coordinate curb requirements, attachment, and location before installation.

B. Roof Openings:

1. Provide exact size and location of roof openings to trade installing structural framing and roof structure.
2. Supervise framing of openings to ensure coordinated installation with air-handling units.

C. Equipment Clearances and Access:

1. Arrange installation of air-handling units to provide access space around air-handling units for service and maintenance and for removal and replacement of internal components.
2. Provide clearance and access required by governing codes and NFPA 70.
3. At a minimum, comply with requirements indicated on Drawings and air-handling unit manufacturer's written instructions.

3.3 PROTECTION DURING CONSTRUCTION

A. Exterior Covers: Cover air-handling units during construction with sealed covers to protect air-handling unit casing and externally mounted components from physical damage, dirt, dust and debris, paint splatter, and any other construction materials.

1. Minor physical damage, as determined by Owner, shall be repaired by air-handling unit factory service personnel to factory-finished condition.
2. Replace air-handling units with damage that in any way compromises the performance indicated.

B. Internal Access: Keep access doors locked to maximum extent possible and restrict access to only authorized personnel.

1. Open access doors only during periods authorized work inside air-handling units is required.
2. Coordinate and monitor work inside air-handling units on a shift basis. Lock access doors once work is complete or at the end of each shift.
3. Immediately report unauthorized access and any observed damage to Owner.

3.4 DUCT CONNECTIONS

A. Connect ducts and plenums to air-handling unit connections. Comply with requirements in Section 233113 "Metal Ducts."

B. Provide duct transitions required to make field connections to air-handling units.

C. Arrange ducts and plenums to provide unobstructed access to inside of air-handling units.

3.5 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to air-handling unit, provide unobstructed access to inside of air-handling units for service and maintenance.

C. Connect piping to air-handling units with flexible connectors.

D. Drain Pan Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping."

1. Make connections to air-handling unit connections with flanges or unions.
2. Extend dedicated drain piping from each air-handling unit connection to nearest roof drain and arrange piping to maintain clear service aisle paths free of potential tripping hazards.
3. Construct traps near air-handling unit connections to seal airflow from escaping within air-handling unit. Locate traps in a serviceable location that is away from access doors.
4. Install threaded cleanouts at changes in direction.
5. Secure drain piping to structure.

E. Chilled-Water Coil Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."

1. Comply with requirements indicated on Drawings.
2. Make connections to coils with a flange or union.
3. Connect to each coil inlet with shutoff valve, test plug, pressure gauge and thermometer.
4. Connect to each coil outlet with balancing valve, test plug, pressure gauge thermometer and shutoff valve.
5. Connect each coil drain connection with a drain valve, which is full size of drain connection. Connect drain pipe to drain valve with union, and extend drain pipe to terminate over roof drain.
6. Connect each coil vent connection with manual vent, which is full size of vent connection.

F. Hot-Water Coil Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."

1. Comply with the requirements indicated on Drawings.
2. Make connections to coils with a flange or union.
3. Connect to each coil inlet with shutoff valve, test plug, pressure gauge and thermometer.
4. Connect to each coil outlet with balancing valve, test plug, pressure gauge thermometer and shutoff valve.
5. Connect each coil drain connection with a drain valve, which is full size of drain connection. Connect drain pipe to drain valve with union, and extend drain pipe to terminate over roof drain.

6. Connect each coil vent connection with manual vent, which is full size of vent connection.

3.6 ELECTRICAL CONNECTIONS

A. Install field power to each air-handling unit electrical power connection. Coordinate with air-handling unit manufacturer and installers.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.7 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

C. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.8 STARTUP SERVICE

A. Engage an air-handling unit factory-authorized service representative to perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, controls, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that face-and-bypass dampers provide full face flow.
7. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.

8. Comb coil fins for parallel orientation.
9. Verify that proper thermal-overload protection is installed for electric heaters.
10. Install new, clean filters.
11. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.9 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

C. Before turning equipment over to Owner for use, adjust air-handling unit components that require further adjustment for proper operation. Consult air-handling unit manufacturer for instruction.

D. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

E. Seasonal Adjustments: Make seasonal visits during warranty period to inspect and review operation of equipment. Make necessary adjustments for components observed to require adjustments for proper operation. Prepare and submit a report to Owner documenting each visit, observations, and any adjustments made.

3.10 CLEANING

A. Cleaning Schedule: After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems, and after completing startup service, and immediately before Owner use, clean air-handling units to remove foreign material and construction dirt and dust.

B. Unit Interior: Clean air-handling units internally to factory clean condition. Remove foreign material and construction debris, dirt, and dust.

1. Vacuum clean with HEPA-filtered vacuum and then wipe down with cleaning solution.
2. Clean casing floors, roofs, wall surfaces, access doors, and panels.
3. Clean all internal components, such as coils, dampers, filter frames, fans, and motors.
4. Clean light fixtures and control devices.

C. Cleaning Materials: Use cleaning materials and products recommended in writing by air-handling unit manufacturer.

D. Acceptance: Following unit cleaning submit a written request for review and Owner acceptance. Acceptance for cleaning of air-handling units must pass a white glove test.

3.11 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory service representative to test and inspect components, assemblies, and equipment installations, including connections.

1. After field piping connections are complete, test hydronic coils and connections for leaks.
2. Charge refrigerant coils with refrigerant and test for leaks.
3. Field-Assembly Supervision: Instruct Installer and supervise field installation of first air-handling unit(s) shipped in multiple pieces for field assembly.
4. Roof-Mounted Field-Installation Supervision: Instruct Installer and supervise field installation of first roof-mounted air-handling unit(s).
5. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
6. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

C. Prepare test and inspection reports.

3.12 OPERATION DURING CONSTRUCTION

A. Operation of air-handling units for temporary cooling, heating, and ventilation is not allowed without Owner authorization.

1. Submit written request for Owner approval by signature with detailed description of operating procedures to be followed including, but not limited to, the following:

    a. Description of construction activities while units are operating.
    b. Operation:

        1) Beginning and ending calendar dates.
        2) List each day during week.
        3) List start and stop time and hours for each day.

    c. Startup procedures and shut-down procedures.
    d. Provisions for routine monitoring of unit operation.
    e. Provisions to prevent and protect against damage to equipment due to adverse operation such as, low temperature, high temperature, over pressure, fire, smoke, electrical over- and undervoltage and current and electrical fault.
    f. Provisions and safeguards for filtration to keep inside of units from getting dirty.
    g. Record keeping.

2. If approved by Owner, units used for temporary cooling, heating, and ventilation during and before interior finish work is complete shall include an unconditional complete unit labor and parts warranty to extend at least two years after the warranty indicated expires.
3. Interior and exterior of air-handling units shall be cleaned to a factory-cleaned condition and clean condition must be accepted by Owner.

B. Filtration During Temporary Use:

1. Protect air-handling system ducts (exhaust air, outdoor air, and return air) with temporary filters installed and supported to prevent filter media from collapse and bypass of unfiltered air. Temporary media shall be installed at each inlet and shall have a published filtration efficiency of MERV 8 in accordance with ASHRAE 52.2.
2. Protect air-handling units with open inlets that are not ducted with temporary filters installed and supported to prevent filter media from collapse and by-pass of unfiltered air. Temporary media shall be installed at each inlet and shall have a published filtration efficiency of MERV 8 in accordance with ASHRAE 52.2.
3. Do not operate air-handling units until both temporary and scheduled permanent air-handling unit particulate filters are in place. Temporary filters must be installed upstream of permanent filters while units are operating.
4. Replace temporary and permanent filters used during construction when dirty. After end of temporary use, replace permanent filters with new, clean filters before beginning testing, adjusting and balancing.

C. Comply with SMACNA 008, "IAQ Guidelines for Occupied Buildings under Construction," for procedures to protect HVAC system.

3.13 DEMONSTRATION

A. Engage air-handling unit manufacturer employed training instructor or factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

B. Training shall include, but not be limited to, procedures and schedules related to performance, safety, startup and shut down, troubleshooting, servicing, preventive maintenance, and how to obtain replacement parts.

1. Access Doors: Adjustment, gasket removal and replacement, handle removal and replacement, and spare parts.
2. Access Panels: Removal and replacement, adjustment, gasket removal and replacement, and spare parts.
3. Coils: Cleaning, combing fins, draining, venting, removal, and replacement.
4. Controls: Calibration, cleaning, operation, service, removal and replacement, and spare parts.
5. Damper Assemblies: Cleaning, operation, service, removal and replacement, and spare parts.
6. Drain Pans: Cleaning, removal, and replacement.
7. Fan and Motor Assemblies: Cleaning, operation, removal and replacement, service, and spare parts.
8. Filters: Operation, removal and replacement, frame gasket removal and replacement, clip removal and replacement, and spare parts.
9. Lights, Receptacles and Switches: Cleaning, operation, service, removal and replacement, and spare parts.

C. Instructor:

1. Instructor shall be factory trained and certified by air-handling unit manufacturer with current training on equipment installed.
2. Instructor's credentials shall be submitted for review by Architect before scheduling training.
3. Instructor(s) primary job responsibility shall be Owner training.

4. Instructor(s) shall have not less than three years of training experience with air-handling unit manufacturer and past training experience on at least three projects of comparable size and complexity.

D. Schedule and Duration:

1. Schedule training with Owner at least 20 business days before first training session.
2. Training shall occur before Owner occupancy.
3. Training shall be held at mutually agreed date and time during normal business hours.
4. Each training day shall not exceed eight hours of training. Daily training schedule shall allow time for a one-hour lunch period and 15-minute break after every two hours of training.
5. Perform not less than eight hours of training.

E. Location: Owner to provide a suitable on-site location to host classroom training. Assume six people.

F. Training Attendance Records: For record purposes, document training attendees at start of each new training session. Record date, time, brief description of training covered during the session, attendee's name, signature, phone number, and e-mail address. Submit scanned copy of sign-in sheet to Owner for each training session.

G. Training Format: Individual training modules to include classroom training followed by hands-on field demonstration and training.

H. Training Materials: Provide training materials in electronic format to each attendee. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.

I. Training Video Recording: Video record each classroom training session and submit an electronic copy to Owner before requesting Owner acceptance of training.

J. Written Acceptance: Obtain Architect or Owner written acceptance that training is complete and requirements indicated have been satisfied.

END OF SECTION 237343.19

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SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Split-system air-conditioners.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Samples for Initial Selection: For units with factory-applied color finishes.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set(s) for each air-handling unit.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."

1.7 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: Five year(s) from date of Substantial Completion.
b. For Parts: Five year(s) from date of Substantial Completion.
c. For Labor: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SPLIT-SYSTEM AIR-CONDITIONERS

A. Indoor Units (5 tons (18 kW) or Less): Refer to Schedule on Design Drawings.

B. Accessories

1. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
2. Drain Hose: For condensate.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

D. Equipment Mounting:

E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

1. Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126

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SECTION 238216.11 - HYDRONIC AIR COILS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hydronic air coils.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil.
2. Include rated capacities, operating characteristics, and pressure drops for each air coil.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. ASHRAE 62.1 Compliance: Comply with applicable requirements in ASHRAE 62.1, Section 5, "Systems and Equipment," and Section 7, "Construction and Startup."

B. Performance Ratings: Tested and rated in accordance with AHRI 410 and ASHRAE 33.

C. Minimum Working-Pressure/Temperature Ratings: 200 psig/300 deg F.

D. Hot-Water Coil Capacities and Characteristics: Refer to Schedule on design drawings.

2.2 HYDRONIC AIR COILS

A. Source Limitations: Obtain hydronic coils from single source from single manufacturer.

B. Description: Coils constructed of staggered tubes mechanically expanded into continuous collars that are die-formed into the coil fins; self-venting; counterflow design of air to fluid.

C. Refer to Schedule on design drawings.

2.3 MATERIALS

A. Aluminum: ASTM B209.

B. Copper Tube: ASTM B75/ASTM 75M annealed temper or ASTM B280 drawn temper.

C. 90/10 Cupronickel Alloy: ASTM B122/ASTM B122M.

D. Corrosion-Resistant Coating: Where indicated on Drawings, coat coils with a corrosion-resistant coating capable of withstanding a 3000-hour salt-spray test in accordance with ASTM B117.

1. Standards:

a. ASTM B117 for salt spray.
b. ASTM D2794 for minimum impact resistance of 100 in. lb.
c. ASTM D3359 for cross-hatch adhesion of 5B.

2. Application: Immersion or spray.
3. Thickness: 1 mil.
4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.4 SOURCE QUALITY CONTROL

A. Hydronic Coils: Factory tested with air while coil is completely submerged underwater to design pressure indicated, but not less than 300-psig internal pressure.

B. Coils to display a tag with the inspector’s identification as proof of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install coils level and plumb.

B. Install coils in metal ducts and casings constructed in accordance with SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

C. Install stainless steel drain pan under each cooling coil.

1. Construct drain pans with connection for drain; insulated and complying with ASHRAE 62.1.

2. Construct drain pans to extend beyond coil length and width and to connect to condensate trap and drainage.
3. Extend drain pan upstream and downstream from coil face.
4. Extend drain pan under coil headers and exposed supply piping.

D. Install moisture eliminators for cooling coils. Extend drain pan under moisture eliminator.

E. Straighten bent fins on air coils.

F. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to coils to allow service and maintenance.

C. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Section 230923 " Direct Digital Control System for HVAC," and other piping specialties are specified in Section 232116 "Hydronic Piping Specialties."

END OF SECTION 238216.11

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SECTION 238219 - FAN COIL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ducted fan coil units.
2. Ductless fan coil units.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include diagrams for power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each type of fan coil unit indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fan coil units to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: Furnish Two spare fan belts for each unit installed.

1.6 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.7 COORDINATION

A. Coordinate layout and installation of fan coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

    a. Compressor failure.
    b. Condenser coil leak.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

2.2 DUCTLESS FAN COIL UNITS

A. Refer to Schedule on design drawings.

2.3 DUCTED FAN COIL UNITS

A. Refer to Schedule on design drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, to receive fan coil units for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping and electrical connections to verify actual locations before fan coil unit installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF FAN COIL UNITS

A. Install fan coil units level and plumb.

B. Install fan coil units to comply with NFPA 90A.

C. Suspend fan coil units from structure with elastomeric hangers.

D. Install new filters in each fan coil unit within two weeks after Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

1. Install piping adjacent to machine to allow service and maintenance.
2. Connect piping to fan coil unit factory hydronic piping package. Install piping package if shipped loose.
3. Connect condensate drain to indirect waste.

    a. Install condensate trap of adequate depth to seal against fan pressure. Install cleanouts in piping at changes of direction.

B. Connect supply-air and return-air ducts to fan coil units with flexible duct connectors specified in Section 233300 "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan coil units.

END OF SECTION 238219

SECTION 239119 - FIXED LOUVERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fixed extruded-aluminum louvers.

1.2 DEFINITIONS

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Wind-Driven-Rain-Resistant Louver: Louver that provides specified wind-driven-rain performance, as determined by testing in accordance with AMCA 500-L.

C. Windborne-Debris-Impact-Resistant Louver: Louver that provides specified windborne-debris-impact resistance, as determined by testing in accordance with AMCA 540.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranties: For manufacturer's special warranties.

1.5 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.6 WARRANTY

A. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked enamel, powder coat, or organic finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.

b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain fixed louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design louvers, including comprehensive engineering analysis by a qualified professional engineer, using structural performance requirements and design criteria indicated.

B. Structural Performance: Louvers withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures are considered to act normal to the face of the building.

1. Wind Loads:

a. Determine loads based on pressures as indicated on Structural Drawings.

C. Windborne-Debris-Impact Resistance: Louvers located within 30 feet of grade pass enhanced protection, when tested in accordance with AMCA 540.

D. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width in accordance with AMCA 500-L.

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

F. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

2.3 FIXED EXTRUDED-ALUMINUM LOUVERS

A. Refer to Schedule in design drawings.

2.4 LOUVER SCREENS

A. Refer to Schedule in design drawings.

2.5 MATERIALS

A. Aluminum Extrusions: ASTM B221, Alloy 6063-T5, T-52, or T6.

B. Aluminum Sheet: ASTM B209, Alloy 3003 or 5005, with temper as required for forming, or as otherwise recommended by metal producer for required finish.

C. Fasteners: Use types and sizes to suit unit installation conditions.

D. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, fabricated from stainless steel components, with allowable load or strength design capacities calculated in accordance with ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing in accordance with ASTM E488/E488M conducted by a qualified testing agency.

2.6 FABRICATION

A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.

C. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

D. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

E. Include supports, anchorages, and accessories required for complete assembly.
   1. mullions at corners.

F. Provide subsills made of same material as louvers or extended sills for recessed louvers.

2.7 ALUMINUM FINISHES

A. Refer to Schedule in design drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Protect unpainted galvanized- and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

F. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 079200 "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

C. Restore louvers damaged during installation and construction, so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 239119

SECTION 260010 - SUPPLEMENTAL REQUIREMENTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. The Instructions to Bidders, General Conditions of the Contract, Supplementary General Conditions and Division 1 bound herewith are a component part of this Division of the specifications and shall apply to this Division with equal force and shall be consulted in detail for instructions pertaining to the work.

2. Requirements generally applicable to all electrical Work on the Project, including but not limited to Work specified in Divisions 26, 27, and 28.

3. Furnish all labor, materials and equipment and incidentals required to make ready for use complete electrical systems as shown on the Drawings and specified herein.

4. It is the intent of these Specifications that the electrical systems shall be suitable in every way for the service required. All material and all work which may be reasonably implied as being incidental to the work of this Division shall be furnished at no extra cost.

B. The work shall include, but not be limited to, furnishing, coordinating, and installing the following:
1. Underground electrical service from pad mounted transformer to service equipment.
2. Electrical distribution system for power, lighting, receptacles and miscellaneous power as shown on the contract drawings.
3. Electrical lighting systems as shown on the contract drawings, complete with indicated switching, circuiting, etc.
4. Electrical receptacle systems as shown on the contract drawings.
5. Exit and emergency lighting systems.
6. Power supplies for equipment furnished by others as detailed in Specification Section 260580.
7. Existing Fire Detection and Alarm System modifications and extensions.
8. Standby emergency power system.
9. Power, raceway, box and outlet systems for low voltage systems provided by the Owner.
10. Power, raceway, box and outlet systems including cabling for data and other special systems.
11. Grounding.
12. Seismic restraint systems.
13. Other special requirements and/or systems where shown.

C. Each bidder (or Representative) shall, before preparing a proposal, visit all areas of the existing site. If the work includes demolition, restoration, renovation and/or addition; then existing buildings and structures should be carefully inspected. The submission of the proposal by this Bidder shall be considered evidence that the Bidder (or Representative) has visited the site and noted the locations and conditions under which the work will be performed and that the Bidder takes full responsibility for a complete knowledge of all factors governing the work.

D. The work shall include complete testing of all equipment and wiring at the completion of work and making any minor correction changes or adjustments necessary for all the proper

functioning of the system and equipment. All work shall be of the highest quality; substandard work will be rejected.

E. Field verify all existing underground electrical and mechanical piping.

F. Field verify and document all existing electrical devices, lighting fixtures, telecom devices (including wireless access points, projectors and smart boards), fire alarm devices, etc. Once construction begins, unless brought to the attention of the Architect/Engineer, it is assumed everything is in working order and the contractor is responsible for ensuring everything is in working order upon re-installation.

1.2 REFERENCES

A. Definitions:

1. 8-Position 8-Contact (8P8C) Modular Jack: An unkeyed jack with up to eight contacts commonly used to terminate twisted pair and multiconductor Ethernet cable. Also called a "TIA-1096 miniature 8-position series jack" (8PSJ), or an "IEC 8877 8-pole jack."
2. Basic Impulse Insulation Level (BIL): Reference insulation level expressed in impulse crest voltage with a standard wave not longer than 1.5 times 50 microseconds and 1.5 times 40 microseconds.
3. Cable: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "cable" is (1) a conductor with insulation, or a stranded conductor with or without insulation (single-conductor cable); or (2) a combination of conductors insulated from one another (multiple-conductor cable).
4. Communications Jack: A fixed connecting device designed for insertion of a communications cable plug.
5. Communications Outlet: One or more communications jacks, or cables and plugs, mounted in a box or ring, with a suitable protective cover.
6. Conductor: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "conductor" is (1) a wire or combination of wires not insulated from one another, suitable for carrying an electric current; (2) (National Electrical Safety Code) a material, usually in the form of wire, cable, or bar, suitable for carrying an electric current; or (3) (general) a substance or body that allows a current of electricity to pass continuously along it.
7. Conduit: A structure containing one or more duct raceways.
8. Direct Buried: Installed underground without encasement in concrete or other protective material.
9. Duct Bank: An arrangement of conduit providing one or more continuous duct raceways between two points.
10. Duct Raceway: A single enclosed raceway for conductors or cable.
11. Electrical Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
12. Enclosure: The case or housing of an apparatus, or the fence or wall(s) surrounding an installation, to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage. Types of enclosures and enclosure covers include the following:

    a. Cabinet: An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung.
    b. Concrete Box: A box intended for use in poured concrete.
    c. Conduit Body: A means for providing access to the interior of a conduit or tubing system through one or more removable covers at a junction or terminal point. In

the United States, conduit bodies are listed in accordance with outlet box requirements.

d. Conduit Box: A box having threaded openings or knockouts for conduit, EMT, or fittings.

e. Cover Plate: A cover designed for protecting wiring devices installed in flush-mounted device boxes while permitting their safe operation; also called a faceplate or wall plate.

f. Cutout Box: An enclosure designed for surface mounting that has swinging doors or covers secured directly to and telescoping with the walls of the enclosure.

g. Device Box: A box with provisions for mounting a wiring device directly to the box.

h. Extension Ring: A ring intended to extend the sides of an outlet box or device box to increase the box depth, volume, or both.

i. Floor Box: A box mounted in the floor intended for use with a floor box cover and other components to complete the floor box enclosure.

j. Floor-Mounted Enclosure: A floor box and floor box cover assembly with means to mount in the floor that is sealed against the entrance of scrub water at the floor level.

k. Floor Nozzle: An enclosure used on a wiring system, intended primarily as a housing for a receptacle, provided with a means, such as a collar, for surface-mounting on a floor, which may or may not include a stem to support it above the floor level, and is sealed against the entrance of scrub water at the floor level.

l. Junction Box: A box with a blank cover that joins different runs of raceway or cable and provides space for connection and branching of the enclosed conductors.

m. Outlet Box: A box that provides access to a wiring system having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for the entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting an outlet box cover, but without provisions for mounting a wiring device directly to the box.

n. Pedestal Floor Box Cover: A floor box cover that, when installed as intended, provides a means for typically vertical or near-vertical mounting of receptacle outlets above the floor's finished surface.

o. Pull Box: A box with a blank cover that joins different runs of raceway and provides access for pulling or replacing the enclosed cables or conductors.

p. Raised-Floor Box: A floor box intended for use in raised floors.

q. Recessed Access Floor Box: A floor box with provisions for mounting wiring devices below the floor surface.

r. Recessed Access Floor Box Cover: A floor box cover with provisions for passage of cords to recessed wiring devices mounted within a recessed floor box.

s. Ring: A sleeve, which is not necessarily round, used for positioning a recessed wiring device flush with the plaster, concrete, drywall, or other wall surface.

t. Ring Cover: A box cover, with raised center portion to accommodate a specific wall or ceiling thickness, for mounting wiring devices or luminaires flush with the surface.

u. Termination Box: An enclosure designed for installation of termination base assemblies consisting of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors, or both.

13. Emergency Systems: Those systems legally required and classed as emergency by municipal, state, federal, or other codes, or by any governmental agency having jurisdiction that are designed to ensure continuity of lighting, electrical power, or both, to designated areas and equipment in the event of failure of the normal supply for safety to human life.

14. Fault Limited: Providing or being served by a source of electrical power that is limited to not more than 100 W when tested in accordance with UL 62368-1.

15. Jacket: A continuous nonmetallic outer covering for conductors or cables.

16. Luminaire: A complete lighting unit consisting of a light source such as a lamp, together with the parts designed to position the light source and connect it to the power supply. It may also include parts to protect the light source or the ballast or to distribute the light.
17. Mode: The terms "Active Mode," "Off Mode," and "Standby Mode" are used as defined in the Energy Independence and Security Act (EISA) of 2007.
18. Multi-Outlet Assembly: A type of surface, flush, or freestanding raceway designed to hold conductors, receptacles, and switches, assembled in the field or at the factory.
19. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein. Also called "single-line diagram."
20. Plenum: A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.
21. Protective Device: A device that senses when an abnormal current flow, abnormal voltage potential, or other abnormal electrical waveform exists and then disconnects the affected portion of the circuit from the system. Common protective devices include fuses, circuit breakers, relays, ground-fault circuit interrupters, and arc-fault circuit interrupters.
22. Public Switched Telephone Network (PSTN): Analog telephone technology that uses twisted pair cables from a telephone-provider central office for the transmission medium. "PSTN" refers to the telephone network; "POTS" refers to the individual subscriber line.
23. Receptacle: A fixed connecting device arranged for insertion of a power cord plug. Also called a power jack.
24. Receptacle Outlet: One or more receptacles mounted in a box with a suitable protective cover.
25. Sheath: A continuous metallic covering for conductors or cables.
26. UL Category Control Number (CCN): An alphabetic or alphanumeric code used to identify product categories covered by UL's Listing, Classification, and Recognition Services.
27. Voice over Internet Protocol (VoIP): Digital telephone packet technology that uses the internet for its transmission medium.
28. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:

    a. Control Voltage: Having electromotive force between any two conductors, or between a single conductor and ground, that is supplied from a battery or other Class 2 or Class 3 power-limited source.
    b. Line Voltage: (1) (controls) Designed to operate using the supplied low-voltage power without transformation. (2) (transmission lines, transformers, SPDs) The line-to-line voltage of the supplying power system.
    c. Extra-Low Voltage (ELV): Not having electromotive force between any two conductors, or between a single conductor and ground, exceeding 30 V(ac rms), 42 V(ac peak), or 60 V(dc).
    d. Low Voltage (LV): Having electromotive force between any two conductors, or between a single conductor and ground, that is rated above 30 V but not exceeding 1000 V.
    e. Medium Voltage (MV): Having electromotive force between any two conductors, or between a single conductor and ground, that is rated about 1 kV but not exceeding 69 kV.
    f. High Voltage: (1) (circuits) Having electromotive force between any two conductors, or between a single conductor and ground, that is rated above 69 kV but not exceeding 230 kV. (2) (safety) Having sufficient electromotive force to inflict bodily harm or injury.

29. Wire: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "wire" is a slender rod or filament of drawn metal. A group of small wires used as a single wire is properly called a "stranded wire." A wire or stranded wire covered with insulation is properly called an

"insulated wire" or a "single-conductor cable." Nevertheless, when the context indicates that the wire is insulated, the term "wire" will be understood to include the insulation.

1.3 COORDINATION

A. All power interruptions to existing equipment shall be at the Owner's convenience with 24 hours (minimum) notice. Each interruption shall have prior written approval.

B. Interruption of Existing Electrical, Telephone, Internet, Security, and Fire-Alarm Services: Do not interrupt services to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify Owner in writing with 24 hours (minimum) notice in advance of proposed interruption of electrical, telephone, internet, security, and fire-alarm services.
2. Coordinate interruption with systems impacted by outage including, but not limited to, the following:

    a. Exercising generators.
    b. Emergency lighting.
    c. Elevators.
    d. Fire-alarm systems.

3. Arrange to provide temporary emergency and standby electrical power so facility may remain occupied during the outage in accordance with requirements specified in Section 015000 "Temporary Facilities and Controls." Coordinate power requirements with Owner.

C. It is understood and agreed that the Contractor is, by careful examination, satisfied as to the nature and location of the work, the conformation of the ground, the character, quality and quantity of the materials to be encountered, the general and local conditions and all other matters which can and may affect the work under this contract. The Contractor shall be held responsible for visiting the site and thoroughly familiarizing himself with the existing conditions and also any contractual requirements as may be set forth in the other Divisions of these Specifications. No extras will be considered because of additional work necessitated by obvious job conditions that are not indicated on the drawings.

D. The Contractor shall compare the electrical drawings and specifications with the drawings and specifications for other trades, and shall report any discrepancies between them to the Architect/Engineer and obtain written instructions for changes necessary in the electrical work. The electrical work shall be installed in cooperation with other trades installing interrelated work. Before installation, the Contractor shall make proper provisions to avoid interferences in a manner approved by the Architect/Engineer. All changes required in the work of the Contractor caused by neglect to do so shall be made at the expense of the Contractor.

E. Location of electrical raceways, switches, panels, switchboards, equipment, fixtures, etc., shall be adjusted to accommodate the work to interferences anticipated and encountered. The Contractor shall determine the exact route and location of each electrical raceway prior to make up and assembly.

1. Right of Way: Lines which pitch shall have the right of way over those which do not pitch. For example, steam, condensate and plumbing drains shall normally have right of way. Lines whose elevations cannot be changed shall have the right of way over lines whose elevations can be changed.

2. Offsets and changes in direction of electrical raceways shall be made as required to maintain proper headroom and to clear pitched lines whether or not indicated on the drawings. The Contractor shall furnish and install elbows, pull boxes, etc., as required to affect these offsets, transitions, and changes in directions. Conflicts between electrical raceways, fixtures, etc., and ductwork or piping which cannot be resolved otherwise, will be resolved by the Architect/Engineer.

F. Installation and Arrangements: The Contractor shall install all electrical work to permit removal (without damage to other parts) of any equipment requiring periodic replacement or maintenance. The Contractor shall arrange electrical raceways and equipment to permit ready access to valves, cocks, traps, starters, motors, control components, etc., and to clear the opening of swinging and overhead doors and of access panels.

1.4 ACTION SUBMITTALS

A. Shop drawings shall be submitted for all equipment, apparatus, and other items as required by the Architect/Engineer. Submit under provisions of relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Submittals are required for all materials shown in the individual specification sections.

C. Submittals are required for materials and specific methods used for penetrations of rated assemblies and for seismic restraints.

D. All shop drawings and submittals shall be submitted at the same time. Partial shop drawing and submittals will be rejected and not processed. Materials, equipment and long lead items that require special handling, if identified and requested by the contractor, will be processed separately.

E. Proposed equipment and/or materials substitutions shall be clearly indicated in shop drawings. All deviations from the specified quality, functionality, appearance or performance of the proposed equipment and/or materials shall be clearly summarized in the preface of each submittal. If none are disclosed, and the deviation specifically approved, the Contractor is responsible for providing the specified materials regardless of submittal approval.

F. The project shall be bid based on the equipment listed in these specifications and on the drawings. After award of the Contract the Contractor may wish to substitute equipment other than that specified, subject to approval. The Electrical Contractor shall bear the “burden of proof” for demonstrating substitute equipment equivalency and suitability.

G. The Electrical Contractor shall be required to replace installed “equivalent” equipment if the operation of this equipment does not meet the full design intent of the specified system.

H. Physical size of equipment used in the design layout are those of reputable equipment manufacturers. The Contractor is responsible for providing equipment which will fit the space provided. If the Contractor elects to use other manufacturer’s equipment, any resulting conflicts with space clearance or codes shall be the responsibility of the Contractor to correct at the Contractor’s expense.

I. The Contractor assumes all responsibility for providing code clearances. Submit a scale drawing of each electrical equipment room showing exact size and location of all proposed electrical equipment with code clearances, dedicated and working space clearly indicated and dimensioned.

1.5 EQUIPMENT AND MATERIALS (GENERAL)

A. In compliance with North Carolina General Statute 133.3, the Architect/Engineer has, wherever possible, specified the required performance and design characteristics of all materials utilized in this construction. In some cases it is impossible to specify the required performance and design characteristics and when this occurs the Architect/Engineer has specified three or more examples of equal design or equivalent design, establishing an acceptable range for items of equal or equivalent design. Cited examples are used only to denote the quality standard of product desired and do not restrict bidders to a specific brand, make, manufacturer or specific name and are used only to set forth and convey to bidders the general style, type, character and quality of product desired. Equivalent products will be acceptable.

B. Substitution of materials, items, or equipment of equal or equivalent design shall be submitted to the Architect/Engineer for approval or disapproval. Equal or equivalent shall be interpreted to mean an item of material or equipment, similar to that named and which is suitable for the same use and capable of performing the same functions as that named, the Architect/Engineer being the judge of equality.

C. The materials used in all systems shall be new, unused and as hereinafter specified and shall bear the manufacturer's name, trade name and third party testing agency label in every case where a standard has been established for the particular material. Equipment furnished under this specification shall be essentially the standard product of manufacturers regularly engaged in the production of the required type of equipment, and shall be the manufacturer's latest approved design. All materials where not specified shall be of the very best of their respective kinds. Samples of materials or manufacturer's specifications shall be submitted for approval as required by the Architect/Engineer.

D. Electrical distribution equipment including switchboards, motor control centers, panelboards, disconnect switches, enclosed circuit breakers, surge protection devices, etc. shall be furnished by the same manufacturer.

E. Protection: Electrical equipment shall at all times during construction be adequately protected against damage. Equipment shall be tightly covered and protected against dirt, water and chemical or mechanical injury and theft. Electrical equipment shall not be stored out of doors. Electrical equipment shall be stored in dry, permanent shelters. If an apparatus has been damaged, such damage shall be repaired at no additional cost. If any apparatus has been subject to possible injury by water, it shall be replaced at no additional cost to the Owner. At the completion of the work, fixtures, equipment, and materials shall be cleaned and polished thoroughly and turned over to the Owner in a condition satisfactory to the Architect/Engineer. Damage or defects, developing before acceptance of the work shall be made good at the Contractor's expense.

F. Any damage to factory applied paint finish shall be repaired using touch up paint furnished by the equipment manufacturer. The entire damaged panel or section shall be repainted per the field painting specifications in Division 9, at no additional cost to the Owner.

G. Where materials such as wiring devices and plates, fire alarm equipment, data cabling system components, etc. are specified to match existing, provide materials to match existing equipment in finish, color, capacity, ratings, operating characteristics, performance, etc.

H. Delivery and Storage: Equipment and materials shall be delivered to the site and stored in original containers, suitably sheltered from the elements, and heated if required to reduce condensation, but readily accessible for inspection by the Architect/Engineer until installed.

I. Equipment and materials of the same general type shall be of the same make throughout the work to provide uniform appearance, operation and maintenance.

J. Manufacturer's directions shall be followed completely in the delivery, storage, protection, and installation of all equipment and materials. The Contractor shall promptly notify the Architect/Engineer, in writing, of any conflicts between any requirements of the Contract Documents and the manufacturer's directions and shall obtain the Architect/Engineer's written instructions before proceeding with the work. Should the Contractor perform any work that does not comply with the manufacturer's direction or such written instructions from the Architect/Engineer, the Contractor shall bear all costs arising in correcting the deficiencies.

1.6 OPERATION AND MAINTENANCE MANUALS

A. Submit under relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. The Contractor shall provide two compilations of catalog data, bound in suitable loose leaf binders, for each manufactured item of equipment used in the electrical work. These shall be presented to the Architect/Engineer for transmittal to the Owner before the final inspection is made. Data shall include printed installation, operation and maintenance instructions for each item, indexed by product with heavy sheet dividers and tabs. All warranties shall be included with each item. Each manufacturer's name, address and telephone number shall be clearly indicated.

C. Shop drawings with Architect/Engineer's "as noted" markings are not acceptable for the above. "Approved" shop drawings are acceptable if adequate information is contained therein. Generally, shop drawings alone are not adequate.

D. Installation information packed with lighting fixtures, devices and equipment shall be retained for inclusion in the operations and maintenance manuals.

1.7 PAINTING

A. All painting will be performed by the General Contractor for the project, unless specifically indicated otherwise. Painting requirements shall adhere to Division 09 – Finishes specification.

B. The Electrical Contractor shall clean all exposed electrical work for painting. Should the Electrical Contractor delay in installing exposed conduit and outlets until the General Contractor has begun painting, the Electrical Contractor shall be required to paint all exposed electrical work at the Electrical Contractor's own expense. Such painting will be accomplished in accordance with the detailed specifications for the Project.

C. Conductors exposed in boxes and cabinets shall be protected against painting. Devices, cover plates, trims, etc., for panelboards and cabinets shall not be installed until painting has been completed.

D. The Electrical Contractor shall be responsible for touch up painting that may be required for electrical material or apparatus furnished with factory applied finish.

1.8 LOCATIONS AND MEASUREMENTS

A. Outlets and appliances are shown and located on the drawings as accurately as possible. All measurements shall be verified on the project and in all cases the work shall suit the surrounding trim, finishes and/or construction. The locations of outlets for special appliances shall be installed so that when extended, they are flush with the finished wall or ceiling and permit the proper installation of fixtures and/or devices. Heights of all outlets shown on the drawings are approximate only. Slight relocations of outlets, devices and equipment shall be made by the Contractor as required or as directed by the Architect/Engineer at no additional cost to the Owner.

1.9 QUALITY OF WORK

All work shall be executed as required by this specification and the accompanying drawings and shall be done by skilled mechanics, and shall present a neat, trim, and mechanical appearance when completed. All work shall be performed as required by the progress of the job.

1.10 SUPERVISION

A. The Contractor shall personally, or through an authorized and competent representative, constantly supervise the work from the beginning to completion and final acceptance. So far as possible, the Contractor shall keep the same foreman and mechanics throughout the project duration.

B. During the progress of the work, it shall be subject to inspection by representatives of the Architect/Engineer, the Owner, and local inspection authorities, at which time the Contractor shall furnish such required information and data on the project as requested.

C. The Electrical Contractor shall coordinate the electrical work with other Contractors and cooperate in the preparation and maintenance of a master schedule for the completion of the project.

1.11 EXCAVATION, TRENCHING AND BACKFILLING

A. The Electrical Contractor shall do all excavating, trenching and backfilling in connection with this contract. All such excavation shall be done in a manner as not to endanger or damage existing utility lines and other structures. If damage occurs, the Contractor shall pay for and repair damage to the satisfaction of the Architect/Engineer.

B. It shall be the responsibility of the Contractor to investigate conditions before excavation and to exercise care during the excavation to avoid any utilities or other objects which may not be shown. Whether or not utilities, etc., are shown on the drawings shall not relieve the Contractor from the responsibility to repair any damage caused by this work. Location of all ditching shall be laid out at grade and shall be approved by the Architect/Engineer before excavating and no work shall be done until such approval has been obtained.

C. All surplus earth shall be removed by the Contractor from the site and disposed of at the Contractor's expense.

D. All excavation, trenching and shoring shall be in accordance with rules and regulations set forth in Article XXI, Bulletin 1 "Trenching" as published in a separate bulletin by the North Carolina Department of Labor, Division of Standards and Inspection Construction Bureau.

E. Backfilling shall be in 6” layers with each layer tamped. No boulders or debris shall be used for backfill material. Where trenching passes through areas designated as streets, driveways, walkways, or parking areas, backfill shall be tamped with power tamps to 95 percent compaction.

F. Excavation shall be bid unclassified with no extra payment for removal of rock.

1.12 CLOSING IN WORK

Work shall not be covered up or enclosed until it has been inspected, tested and approved by the authorities having jurisdiction over this work. Should any of the work be enclosed or covered up before such inspection and test, the Contractor shall uncover the work at the Contractor’s expense; after it has been inspected, tested and approved, the Contractor shall restore the work to its original condition. **The State Electrical Inspector at the State Construction Office shall be called for all inspections at 984-236-5414.**

1.13 REFERENCE STANDARDS

A. All electrical equipment, materials, and installation shall be in accordance with the latest edition of the following codes and standards:

1. American Association of Edison Illuminating Companies (AEIC)
2. American National Standards Institute (ANSI)
3. American Society for Testing and Materials (ASTM)
4. Building Officials Code Administrators (BOCA)
5. Energy Code 90.1 (ASHRAE/IES)
6. Institute of Electrical and Electronic Engineers (IEEE)
7. Insulated Cable Engineers Association (ICEA)
8. International Code Council (ICC)
9. International Conference of Building Officials (ICBO)
10. National Electrical Code (NEC) 2023 edition
11. National Electrical Contractor’s Association (NECA)
12. National Electrical Installation Standards (NEIS)
13. National Electrical Manufacturer’s Association (NEMA)
14. National Electrical Safety Code (NESC)
15. National Fire Protection Association (NFPA)
16. North Carolina Energy Conservation Code, 2012 (NCECC)
17. North Carolina State Building Code (NCSBC)
18. North Carolina Construction Manual with GS as listed (NCCM)
19. Occupational Safety and Health Act (OSHA)
20. Requirements of the Americans with Disabilities Act (ADA), latest edition.
21. Underwriters Laboratories Inc. (U.L.)
22. Southern Building Code Congress International (SBCCI)
23. Toxicity Characteristics Leaching Procedure (TCLP)

B. All electrical equipment and material shall be listed by a qualified third party testing agency. Acceptable qualified third party testing laboratories/agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Electrical & Mechanical Equipment. Equipment and materials shall bear the appropriate testing agency’s listing mark or classification marking. Equipment, materials, etc. utilized not bearing a third party testing agency certification shall be field or factory third party testing agency certified prior to equipment acceptance and use.

C. Where reference is made to one of the above standards, the revision in effect at the time of the bid opening shall apply.

1.14 ENCLOSURE TYPES

A. Unless otherwise specified herein or shown on the Drawings, electrical enclosures shall have the following rating:
   1. NEMA 4X.

1.15 CODES, INSPECTION AND FEES

A. All equipment, materials and installation shall be in accordance with the requirements of the local authority having jurisdiction, which is the State Construction Office.

B. The electrical contractor shall notify the State Electrical Inspectors in the State Construction Office to schedule required inspections. Required electrical inspections will be performed Monday through Friday unless specifically authorized by the State Construction Office. No work will be covered up until after inspection has been completed and approved by authorized SCO inspector.

1.16 TESTS AND SETTINGS

A. Test all systems furnished under Division 26, 27 & 28 and repair or replace all defective work. Make all necessary adjustments to the systems and instruct the Owner's personnel in the proper operation of the systems.

B. See other Specification Sections for specific testing and acceptance requirements.

C. Make the following minimum tests and checks prior to energizing electrical equipment:

   1. Mechanical inspection, testing and settings of all circuit breakers, disconnect switches, motor starters, control equipment, etc., for proper operation.
   2. Check all wire and cable terminations. Verify to the Architect/Engineer that connections meet the equipment torque requirements.
   3. Check rotation of motors, obtain permission from other contractors to start motor, and proceed to check for proper rotation. If the motor rotates in the wrong direction, correct it. Take all necessary precautions not to damage any equipment.
   4. Provide all instruments and equipment for the tests specified herein.

D. All testing shall be scheduled and coordinated by the Contractor. Notify the Owner at least two (2) weeks in advance of conducting tests. The Contractor shall have qualified personnel present during all testing.

E. All tests shall be completely documented with the time of day, date, temperature, and all other pertinent test information. All required documentation of readings indicated shall be submitted to the Architect/Engineer prior to, and as one of the prerequisites for, final acceptance of the project.

F. Electrical Distribution System Tests: All current carrying phase conductors and neutrals shall be tested as installed, and before load connections are made, for insulation resistance and accidental grounds. This shall be done with a 500 volt megger. The following procedures shall be as follows:

1. Minimum readings shall be one million (1,000,000) ohms or more for #6 AWG wire and smaller; 250,000 ohms or more for #4 AWG wire or larger. Measurement to be taken between conductors and between conductor and the grounded metal raceway.
2. After all fixtures, devices and equipment are installed and all connections completed to each panel, the Contractor shall disconnect the neutral feeder conductor from the neutral bar and take a megger reading between the neutral bar and grounded enclosure. If this reading is less than 250,000 ohms, the Contractor shall disconnect the branch circuit neutral wires from this neutral bar. The Contractor shall then test each one separately to the panel until the low reading ones are found. The Contractor shall correct troubles, reconnect and retest until at least 250,000 ohms from the neutral bar to the grounded panel can be achieved with only the neutral feeder disconnected.
3. The Contractor shall send a letter to the Architect/Engineer, and to the North Carolina State Construction Office certifying that the above has been done and tabulating the megger readings for each panel. This shall be done at least four (4) days prior to final inspection.
4. At inspection, the Contractor shall furnish a megger and show Architect/Engineer's representative that the panels comply with the above requirements. The Contractor shall also furnish a clamp type ammeter and a voltmeter and take current and voltage readings as directed by the representatives.
5. At inspection, the Contractor shall furnish ladders, required tools, and mechanics to open fixtures, boxes, panels, or any other equipment to enable the Architect/Engineer's representatives to see into any parts of the installation that may be requested.

G. Electrical Grounding System Tests: Provide documentation showing values of earth ground impedance for the system ground. See Specifications Section 260526 "Grounding and Bonding for Electrical Systems" for testing requirements.

H. For services 1000 amperes and larger, the following circuit breaker tests shall be performed on the service circuit breakers and all distribution circuit breakers by a qualified factory technician at the project site. All readings shall be tabulated and submitted to the Architect for approval.

1. Phase tripping tolerance (within 20% of UL requirements).
2. Trip time (per phase) in seconds.
3. Instantaneous trip (amperes) per phase.
4. Insulation resistance (in megaohms) at 100 volts (phase to phase and line to load).

I. Ground Fault Protection System: Ground fault protection shall be performance tested in the field and properly calibrated and set in accordance with the coordination study. In the absence of a coordination study, set all adjustments to minimum, unless directed otherwise by the Architect/Engineer.

1.17 SLEEVES AND FORMS FOR OPENINGS

A. Anchor bolts, sleeves, inserts, supports, etc., that may be required for electrical work shall be furnished, located and installed by the Electrical Contractor. The Electrical Contractor shall give sufficient information (marked and located) to the General Contractor in time for proper placement in the construction schedule. Should the Electrical Contractor delay or fail to provide sufficient information in time, then the Electrical Contractor shall cut and patch construction as necessary and required to install electrical work. Such cutting and patching will be done by the General Contractor but paid for by the Electrical Contractor.

B. Provide and place all sleeves for conduits penetrating floors, walls, partitions, etc. Locate all necessary slots for electrical work and form before concrete is poured.

C. Where exact locations are required by equipment for stubbing up and terminating conduit concealed in floor slabs, request shop drawings, equipment location drawings, foundation drawings, and any other data required to locate the concealed conduit before the floor slab is poured.

D. Where such data is not available in time to avoid delay in scheduled floor slab pours, the Architect/Engineer may elect to allow the installations of such conduits to be exposed. No additional compensation for such change will be allowed and written approval must be obtained from the Architect/Engineer.

E. Seal all openings, sleeves, penetration, and slots as specified and as shown on the Contract Drawings.

1.18 CUTTING AND PATCHING

A. For the purposes of the Electrical Contract, “cutting and patching” shall be defined as that work required to introduce new electrical work into existing construction. Work required to install or fit electrical boxes, conduit, enclosures, equipment, etc. into new construction is not “cutting and patching”.

B. The Electrical Contractor shall perform all cutting and patching necessary to install all equipment as required under his contract and shall re-establish all finishes to their original condition where cutting and patching occur.

C. All cutting and patching shall be done in a thoroughly workmanlike manner.

D. Core drill holes in existing concrete floors and walls as required.

E. Install work at such time as to require the minimum amount of cutting and patching.

F. Do not cut joists, beams, girders, columns or any other structural members without first obtaining written permission from the Architect/Engineer.

G. Cut opening only large enough to allow easy installation of the conduit.

H. Patching is to be of the same kind of material as was removed.

I. The completed patching work shall restore the surface to its original appearance.

J. Patching of waterproofed surfaces shall render the area of the patching completely waterproofed.

K. Remove rubble and excess patching materials from the premises.

L. Raceways and ducts penetrating rated floor, ceiling or wall assemblies shall be properly sealed in accordance with the corresponding Underwriters Laboratories approved method utilizing approved and listed materials.

1.19 INTERPRETATION OF DRAWINGS

A. The Electrical drawings and specifications are complementary each to the other and what may be called for by one shall be as binding as if called for by both. The drawings are diagrammatic and indicate generally the location of outlets, devices, equipment, wiring, etc. Drawings shall be

followed as closely as possible; however, all work shall suit the finished surroundings and/or trim.

B. Do not scale electrical drawings. Refer to the architectural drawings for dimensions.

C. Where the words “furnish and install” or “provide” are used, it is intended that this contractor shall purchase and install completely any and/or all material necessary and required for this particular item, system, equipment, etc.

D. Where the words “the Contractor” or “this Contractor” appear in either the Electrical Drawings or Division 26, 27, and 28 Specifications, it shall mean the Electrical Contractor.

E. Any omission from either the drawings or these specifications are unintentional, and it shall be the responsibility of this Contractor to call to the attention of the Architect/Engineer any pertinent omissions before submitting a bid. Complete and working systems are required, whether every small item of material is shown and specified or not.

F. Where no specific material or equipment type is mentioned, a high quality product of a reputable manufacturer may be used provided it conforms to the requirements of these specifications. These materials shall be listed or labeled by a Third Party Testing Agency accredited by the NCBCC to label electrical equipment.

G. The electrical drawings show the general arrangement of raceways, equipment, fixtures, and appurtenances and shall be followed as closely as actual building construction and the work of other trades will permit. Some adjustment of routings and installation of conduit, cable tray and devices should be expected. The electrical work shall conform to the requirements shown on all of the drawings. General and Structural drawings shall take precedence over Electrical Drawings. Because of small scale of the electrical drawings, it is not possible to indicate offsets, fittings and accessories which may be required. The Contractor shall investigate the structural and finish conditions affecting the work and shall arrange his work accordingly, providing such fittings and accessories as may be required to meet such conditions, without additional cost to the Owner and as directed by the Architect/Engineer.

H. Each 3-phase circuit shall be run in a separate conduit unless otherwise shown on the Drawings.

I. Unless otherwise approved by the Architect/Engineer, conduit shown exposed shall be installed exposed; conduit shown concealed shall be installed concealed.

J. Where circuits are shown as “home runs” all necessary fitting and boxes shall be provided for a complete raceway installation.

K. Verify with the Architect/Engineer the exact locations and mounting heights of lighting fixtures, switches and receptacles prior to installation.

L. Any work installed contrary to or without approval by the Architect/Engineer shall be subject to change as directed by the Architect/Engineer, and no extra compensation will be allowed for making these changes.

M. The locations of equipment, fixtures, outlets, and similar devices shown on the Drawings are approximate only. Exact locations shall be as approved by the Architect/Engineer during construction. Obtain in the field all information relevant to the placing of electrical work and in case of any interference with other work, proceed as directed by the Architect/Engineer and furnish all labor and materials necessary to complete the work in an approved manner.

N. Surface mounted panel boxes, junction boxes, conduit, etc., shall be supported by spacers to provide a clearance between wall and equipment.

O. Circuit layouts are not intended to show the number of fittings, or other installation details. Furnish all labor and materials necessary to install and place in satisfactory operation all power, lighting, and other electrical systems shown. Additional circuits shall be installed wherever needed to conform to the specific requirements of equipment.

P. All connections to the equipment shall be made as required, and in accordance with the approved shop and setting drawings.

Q. Redesign of electrical work, which is required due to the Contractor's use of an alternate item, arrangement of equipment and/or layout other than specified herein, shall be done by the Contractor at the Contractor's expense. Redesign and detailed plans shall be submitted to the Architect/Engineer for approval. No additional compensation will be provided for changes in the work, either the Electrical Contractor's or others, caused by such redesign.

R. All floor mounted electrical equipment shall be placed on 4 inch thick concrete housekeeping pads. Edges shall be chamfered.

1.20 SIZE OF EQUIPMENT

A. Investigate each space in the structure through which equipment must pass to reach its final location. If necessary, the manufacturer shall be required to ship his materials in sections sized to permit passing through such restricted areas in the structure.

B. The equipment shall be kept upright at all times. When equipment has to be tilted for ease of passage through restricted areas during transportation, the manufacturer shall be required to suitably brace the equipment, to ensure that the tilting does not impair the functional integrity of the equipment.

1.21 EXISTING BUILDINGS AND CONSTRUCTION

A. The Contractor is cautioned that some of the work to be performed under this contract is to be accomplished adjacent to and in an existing occupied building. All such work shall be scheduled and arranged to be done at the convenience of the Owner so as not to interfere with, disrupt, or disturb normal operations in the building. The Contractor shall obtain approval from the Owner before proceeding with work in existing buildings and shall work in existing buildings on schedule as agreed upon with the Owner. This is not to be necessarily construed to mean that the Contractor is expected to perform work on buildings on holidays, weekends, etc., but that the Contractor must schedule work with the Owner for the Owner's beneficial and normal usage of the buildings, and that the Contractor will be required to maintain the schedule as approved by the Owner.

B. The Contractor shall, at all times, must ensure that all egress paths, exits and exit discharge routes are kept clear and unimpeded at all times and provide safety barriers, protective devices, screening, dust barriers, etc., as required to maintain the safety and comfort of the building's personnel and/or occupants in or near the work area.

C. The Contractor shall be responsible for cleanup in connection with work in existing buildings. At the end of each working day, all debris, boxes, waste, etc., shall be removed from the buildings and properly disposed of. Equipment, materials, etc., may be left inside the buildings, but such must be properly stored, stacked and located as approved by the Owner.

D. The Contractor shall do all cutting, patching, finishing, repairing, painting, etc., necessary for electrical work to be installed in existing buildings. All finishes shall be left to equal finish and condition prior to cutting. No cutting of structural members will be allowed. All cutting of walls, floors, roofs, etc., shall be repaired and/or replaced to equal finish prior to cutting. The Contractor shall route conduits and locate equipment as approved by the Owner and Architect/Engineer. Routings and locations shall be firmly established and approved before proceeding with any phase of the work.

E. The Contractor shall be responsible for any and all damage to the existing buildings, grounds, walkways, paving, etc., caused by the work, the Contractor and/or Contractor's personnel, and/or Contractor's equipment in the accomplishment of this work. Such damages shall be repaired and/or replaced by the Contractor at no additional cost to the Owner, to finish equal to that finish prior to damage. The Architect/Engineer shall be the judge as to equal finishes, etc.

1.22 RECORD DRAWINGS

A. As the work progresses, legibly record all field changes on one set of project contract drawings, herein after called the "record drawings".

B. Record drawings shall accurately show the installed condition of the following items:
1. Power distribution one line diagram(s).
2. Switchboards.
3. Panelboards.
4. Enclosed Circuit Breakers.
5. Disconnect Switches.
6. Motor Control Centers.
7. Dry Type Transformers.
8. Standby Power System.
9. Docking Station.
10. Control wiring diagram(s).
11. Lighting fixture schedule(s).
12. Service, feeder, branch circuit conduit and conductor sizes.
13. Lighting fixture, receptacle, and switch outlets, interconnections and homeruns with circuit identification.
14. Underground raceway routing.
15. Plan view, sizes and locations of switchboards, distribution transformers, transfer switches, motor control centers, and panelboards.
16. Fire alarm system.
17. Data cabling system.

1.23 CORROSION PROTECTION

A. All equipment enclosures, raceways, raceway, box and equipment supporting materials, hardware, etc., shall be fabricated of 316 series stainless steel unless specifically noted otherwise. In Non-Corrosive Atmosphere Spaces listed on Drawings Sheet E-6.16, materials noted above may be protected from corrosion by factory applied coatings, paint and galvanizing. All exposed hardware shall be 316 series stainless steel. The requirements of preceding section entitled "Delivery and Storage" shall be strictly followed. Touch up any scratched metallic surfaces immediately to prevent corrosion. Apply cold galvanizing compound to all galvanized surfaces damaged during installation, i.e., cutting, etc. Rusted or corroded materials shall be replaced before final acceptance of the work.

1.24 SEISMIC REQUIREMENTS

A. All equipment furnished under the electrical contract shall be installed in a manner to be fully compliant with the seismic restraint requirements of the North Carolina State Building Code (NCSBC). The Contractor shall provide any and all seismic restraint details and calculations that may be required by the NCSBC and/or the Authority Having Jurisdiction.

B. Requirements for restraints are detailed in the NCSBC. All tables and references shall conform to building's location. Restraints shall be per Seismic Performance Category stated on Architectural Drawings.

C. The Contractor shall retain the services of a Professional Engineer registered in the State of North Carolina to design seismic restraint elements required for this project. The Engineer's calculations, bearing his professional seal, shall accompany shop drawings and shall demonstrate Code compliance including certification that the seismic system components comply with the testing requirements of NCSBC Section 1708.5. Calculations and shop drawings shall be submitted for review prior to the purchasing of materials, equipment, systems and assemblies. Internal seismic restraint elements of manufactured equipment shall be certified by a professional engineer retained by the manufacturer. Such certificate applies only to internal elements of the equipment. All equipment anchorage requirements shall be coordinated with the building structure and shall be compatible thereto. All such anchorages shall be subject to the review and approval of the project's structural engineer.

D. The Professional Engineer retained for seismic restraint calculations shall visit the job site upon completion of the seismic restraint installation to comply with the Special Inspections requirement of the Code. This engineer shall provide written verification of compliance of the installation with the approved seismic submittal. This verification shall be submitted as a Special Inspections Report and shall bear the Engineer's professional seal. Job site inspections by other than this engineer are not acceptable.

E. Review of the seismic design computations and shop drawings by the Architect/Engineer or his agent shall not relieve the Contractor of his responsibility to comply with the seismic or any other requirements of the North Carolina State Building Code.

1.25 GUARANTEE

The Contractor shall guarantee the materials and workmanship covered by these drawings and specifications for a period of one year from the date of acceptance by the Owner. The Contractor shall repair and/or replace any parts of any system that may prove to be defective at no additional cost to the Owner within the guarantee period. All equipment warranties shall be as specified and included in the Contract Documents.

1.26 PHASING OF THE WORK

The Electrical Contractor shall schedule his work as described in the relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

1.27 ALTERNATE BIDS

Alternate bid items are described in relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

1 PART 2 - PRODUCTS Not Used

2 PART 3 - EXECUTION Not Used

3 END OF SECTION 260010

SECTION 260510 – SELECTIVE ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Selective electrical demolition shall be provided by the Electrical Contractor as described herein and as shown on the contract drawings. Gross demolition will be provided by the General Contractor. Identify active utilities, and at the appropriate time, disconnect and cap off such utilities and provide experienced personnel on site during General Contractor demolition operations to perform such operations and resolve issues. Remove materials noted for salvage and reuse.

B. Related Requirements:

1. Division 2 – Demolition

C. References:

1. NFPA 70 – National Electrical Code.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify field measurements and circuiting arrangements are as shown on Drawings.

B. Verify that abandoned wiring and equipment serve only abandoned facilities.

C. Demolition Drawings are based on limited field observation and existing record documents. Survey the affected areas before submitting bid proposal. Report discrepancies to the Architect/Engineer before disturbing the existing installation.

D. Beginning of demolition means the Contractor accepts existing conditions.

3.2 PREPARATION

A. Identify and mark wiring to remain for the General Contractor.

B. Disconnect and/or de-energize electrical systems in walls, floors, and ceilings scheduled for removal.

C. Coordinate power outages with the Owner and Utility Company.

D. Continuous service is required on many circuits and outlets affected by these changes, except where the Owner will permit an outage for a specific time. Provide temporary and/or permanent wiring and connections as shown and/or as required by conditions to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, and when such work is specifically approved by the Owner, use personnel experienced in such operations.

E. Protect existing circuits to remain and extend as required utilizing matching conductors and conduit size and type.

F. Protect all existing active utility and standby power, communications, data, life safety, security and fire alarm systems and maintain them in operation throughout the progress of the work. Notify the Owner and Architect/Engineer in writing if shutdowns are required prior to any outage of service. Where the duration of a proposed outage cannot be tolerated by the Owner, provide temporary connections as required to maintain service.

G. Trace out existing wiring that is to be relocated or removed and perform the relocation or removal work as required for a complete operating and safe system. Provide temporary and/or permanent wiring and connections as shown and/or as required by conditions to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, and when such work is specifically approved by the Owner, use personnel experienced in such operations.

H. Existing Electrical Services: Maintain existing systems in service. Disable systems only to make switchovers and connections. Obtain written permission from the Owner at least 24 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

I. Existing Standby Power Generators: Remove the existing standby generators after the new standby generators are installed, tested and operational or after temporary standby generators are installed tested and operational. All cutover work shall be done after facility normal business hours and on weekends. Disable systems only to make switchovers and connections. Obtain written permission from the Owner at least 72 hours before partially or completely disabling systems. Minimize outage duration.

J. Existing Fire Alarm System: Coordinate work with Johnson Controls/Simplex, the Owner's fire alarm system vendor, and maintain the existing system in service until the new system is accepted. Disable system only to make switchovers and connections. Notify the Owner and local fire service in writing at least 24 hours before partially or completely disabling system. Limit outages to normal business hours only and minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. Establish and maintain a 24 hour/day approved fire watch if the system must be taken out of service.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Demolish and extend existing electrical work under provisions of relevant sections of the General and Supplemental General Conditions, Division 1 Specifications Sections, Section 260010 - Supplemental Requirements for Electrical and this Section.

B. Identify and mark wiring to remain for the General Contractor.

C. Remove materials designated for salvage and reuse.

D. Remove, relocate, and extend existing installations to accommodate new construction.

E. Remove disconnected and abandoned wiring to source of supply.

F. Remove electrical work associated with equipment scheduled for demolition except those portions indicated to remain or be reused. Remove unused/abandoned exposed conduit and wiring, including abandoned conduit above accessible ceiling finishes, back to point of concealment. Remove unused/abandoned wiring in concealed conduits back to source (or nearest point of usage). Cut conduit flush with walls and floors, and patch surfaces.

G. Remove exposed wireways, outlet boxes, pull boxes, and hangers made obsolete by the alterations, unless specifically designated to remain.

H. Where electrical systems pass through the renovation areas to serve other portions of the premises, they shall remain or be suitably relocated and the system restored to normal operation. Coordinate outages in systems with the Owner. Where duration of proposed outage cannot be allowed by the Owner, provide temporary connections as required to maintain service.

I. Repair adjacent construction and finishes damaged during electrical demolition and extension work.

J. Disconnect and remove abandoned luminaires where noted. Remove brackets, stems, hangers, and other accessories.

K. Disconnect and remove electrical devices serving utilization equipment that has been removed.

L. Disconnect and remove abandoned panelboards and distribution equipment as noted.

M. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.

N. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

O. Continuous service is required on all circuits and outlets affected by these changes, except where the Owner will permit an outage for a specific time. Obtain Owner's consent before removing any circuit from continuous service.

P. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.4 DISPOSAL, CLEANING AND REPAIR

A. In general, it is intended that material and equipment indicated to be removed and disposed of by the Electrical Contractor shall, upon removal, become the Contractor's property and shall be disposed of, off the site, by the Contractor unless otherwise directed by the Owner. A receipt showing acceptable disposal of any legally regulated materials or equipment shall be given to the Owner.

B. Clean and repair existing materials and equipment which remain or are to be reused.

C. Panelboards: Clean exposed surfaces and check tightness. Provide new typed circuit directories showing revised circuiting arrangement.

D. All salvageable materials shall be properly stored by the Electrical Contractor until installed in new construction.

3.5 INSTALLATION

A. Install relocated materials and equipment under the provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

END OF SECTION 260510

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Building wires and cables rated 600 V and less.
2. Lighting Control Cable.
3. Connectors, splices, and terminations rated 600 V and less.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
2. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding of lighting control devices referenced by this Section.
3. Section 260533.13 “Conduits for Electrical Systems” specifies conduit referenced by this Section.
4. Section 260533.16 "Boxes and Covers for Electrical Systems" specifies covers and cover plates referenced by this Section.
5. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.

C. References:

1. ANSI/NFPA 70 National Electrical Code.
2. NECA Standard of Installation (National Electrical Contractors Association).

1.2 ACTION SUBMITTALS

A. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: For each type of product. Provide manufacturer’s catalog information showing dimensions, ratings, colors, and configurations.

1.3 INFORMATIONAL SUBMITTALS

A. Test and Field quality-control reports. Indicate procedures and values obtained.

B. Manufacturer’s Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

1.5 PROJECT CONDITIONS

A. Unless noted otherwise, all wire and cable shall be installed in non-metallic conduit. This includes all power wiring, fire alarm, emergency systems control conductors, sound and communications wire and cable, lighting control cable, HVAC control cable, etc. and other electrical systems required by Codes to be installed in raceways.

B. Verify that field measurements are as shown on Drawings.

C. Conductor sizes are based on 75° C. copper.

D. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project Conditions.

E. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

1.6 COORDINATION

A. Coordinate Work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Description: Single conductor insulated building wire.

B. Conductor: Copper. Solid and stranded as specified below. Minimum #12 AWG, maximum 500 KCMil.

C. Insulation/Voltage Rating: 600 volts.

D. Insulation: Dual-rated THHN/THWN or XHHW.

E. Color Coding:

	120/240 volts and 208/120 volts	480/277 volts
Phase A -	Black	Brown
Phase B -	Red	Orange
Phase C -	Blue	Yellow
Neutral -	White*	Gray*
Ground -	Green	Green

*Provide neutral conductors with factory color coded markings or stripes identified for their associated phase conductor (white-black, white-blue, white-red, gray-brown, gray-orange, gray-yellow) where individual neutral conductors are required.

2.2 ALUMINUM FEEDER CONDUCTOR OPTION

A. The Contractor may provide aluminum conductors for service entrance and large feeders. Such conductors shall result in equal ampacity to the copper service entrance and feeders they replace and comply with Para. 2.1 above and other requirements of Division 26. The contractor is responsible for obtaining written approval from the Architect/Engineer for all proposed changes prior to installation. Raceways shall be upsized and quantities increased as required to maintain service entrance and feeder ampacity. Installation shall conform to conductor and connector manufacturer's recommendations including oxide inhibitor use and properly torqued connections. Maintain all NEC required spacing inside cabinets at terminations.

1. AA-8000 series aluminum conductors may be substituted for copper service entrance and feeder conductors in size #4/0 AWG and larger (i.e.; #2/0 AWG copper replaced with #4/0 AWG aluminum. Copper conductors in size #1/0 and smaller shall remain copper.).
2. The maximum aluminum conductor size shall be 500 KCMil.
3. All aluminum conductor terminations shall be made with machine applied compression connectors and individually field verified and certified in writing by the contractor to be installed per the conductor and equipment manufacturer's recommendations. Insulation shall be removed by "penciling" or using a manufacturer-approved insulation removal tool that does not nick the underlying conductor. Do not "ring cut" insulation. Wire brush the conductor and apply conductor manufacturer approved oxide inhibitor prior to terminating, unless the compression connector is prefilled with inhibitor, all as recommended by the manufacturer.

2.3 LIGHTING CONTROL CABLE

Lighting control cable for dimming and occupancy sensor control shall be provided as required and as approved by NEC Article 725. Cable shall be NEC Type CMP, in raceway from the switch outlet box or dimming panel to the accessible ceiling cavity, then free run to follow the lighting power system raceways to the fixtures controlled, be secured to the structure to the plane of the lighting power raceway system, then supported by the lighting power raceway system using NEC approved cable ties installed on no more than six foot intervals, or less if required by Codes and the AHJ. Lighting control cable shall be plenum rated and be approved by the lighting controls manufacturer. It shall consist of a 2#18 AWG solid, violet and gray insulated conductors minimum with an outer jacket rating of 300V minimum. Cable outer jacket shall not be red. Cable shall be daisy chain connected to lighting fixtures or be taped in junction boxes installed at the same plane of the lighting power raceway system. Do not support cable with ceiling grid supports wires. Do not drape cable over ceilings, lighting fixtures, conduit, ductwork, piping or equipment. Daisy chaining cable at the ceiling level is not permitted.

2.4 WIRING CONNECTORS AND CONNECTIONS

A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

B. Conductors shall be installed continuous from outlet to outlet with no splicing except within outlet or junction boxes, troughs and gutters. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

C. Use mechanical connectors for copper conductor splices and taps, 8 AWG and larger, except main grounding conductors, which shall be terminated with compression lugs. Tape un-insulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor or use third party testing agency-approved insulating covers.

D. Use insulated spring wire connectors with plastic caps for copper conductors, 10 AWG and smaller, splices and taps in junction boxes, outlet boxes and lighting fixtures, Ideal “Wire-Nut” or “Wing-Nut”, 3M Company “Scotchlock” series or NSI “Easy-Twist”. “Push wire” type connectors are not acceptable.

E. “Sta-Kon” or other permanent type crimp connectors shall not be used for branch circuit connections.

F. Joints in stranded conductors shall be spliced by approved mechanical connectors and insulated with vinyl mastic tape and covered with vinyl electrical tape, 3M Scotch Vinyl Mastic Tape 2210 and Scotch Vinyl Electrical Tape Super 88, respectively, or approved equal. Solderless mechanical connectors for splices and taps, provided with U.L approved insulating covers, may be used instead of mechanical connectors plus tape.

2.5 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that mechanical work likely to damage wire has been completed.

C. Verify that raceway installation is complete and supported.

3.2 PREPARATION

A. Completely and thoroughly swab raceway before installing wire.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Install products in accordance with manufacturer’s instructions.

B. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

C. Install cable in accordance with the NECA “Standard of Installation”.

D. Complete raceway installation between conductor and cable termination points according to Section 260533.13 "Conduits for Electrical Systems" prior to pulling conductors and cables.

E. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values. Completely and thoroughly swab raceway before installing wire.

F. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

G. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

H. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

I. Use solid conductor for feeders and branch circuits 10 AWG and smaller, and Class B stranded for larger conductors.

J. Use conductor not smaller than 12 AWG for power and lighting circuits. Use conductor not smaller than 14 AWG for fire alarm and control circuits.

K. Pull all conductors into raceway at same time.

L. Where size is not shown on the Drawings, branch circuits shall consist of #12 AWG or #10 AWG minimum phase, neutral and equipment ground conductors in 3/4” minimum raceway. Refer to the “Minimum Conductors Size Chart” on the Drawings and increase conductors sizes as required to maintain a maximum of 3% voltage drop. Comply with Notes of Minimum Conductors Size Chart.”

M. Neatly train and lace wiring inside boxes, equipment, panelboards, switchboards, automatic transfer switches, etc.. Do not tightly bundle conductors.

N. Identify each conductor with its circuit number or other designation indicated on Drawings.

O. Clean conductor surfaces before installing lugs and connectors.

P. Common neutral multiwire receptacle branch circuits are not permitted. Provide separate, individual neutral conductors for receptacle and lighting circuits.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

C. Conductors shall be installed continuous from outlet to outlet with no splicing except within outlet or junction boxes, troughs and gutters. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.8 FIELD QUALITY CONTROL

A. Perform field inspection and testing under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Inspect wire for physical damage and proper connection.

C. Measure tightness of bolted connections and compare torque measurements with manufacturer’s recommended values.

D. Verify continuity of each branch circuit conductor

E. Prior to energizing, feeders, sub-feeders and service conductor cables shall be tested for electrical continuity and short circuits. A copy of these tests shall be sent to the North Carolina State Construction Office through the Architect/Engineer. A copy of these tests shall be retained on site as part of the project record documents for review at time of final project inspection. A copy of these tests shall be sent to the Architect/Engineer.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Grounding electrodes and conductors.
2. Equipment grounding conductors.
3. Grounding well components.
4. Ground Bars.

B. Related Sections:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
2. Section 260519 "Low-Voltage for Electrical Power Conductors and Cables" specifies nonmetallic underground conduit with conductors (Type NUCC).
3. Section 260533 – “Conduit for Electrical Systems” referenced by this Section.
4. Section 260534 – “Boxes and Covers for Electrical Systems” referenced by this Section.
5. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.

C. References:

1. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
2. NFPA 70 - National Electrical Code.

1.2 GROUNDING SYSTEM DESCRIPTION

A. The neutral of each secondary electrical distribution system shall be grounded at one point only which shall be at the main disconnecting device. From the main disconnecting device, a copper grounding conductor sized in accordance with the NEC shall be extended to the earth electrode. Main grounding conductors #8 AWG through and including #4 AWG shall be insulated and identified by a green colored insulation. All grounding conductors shall be installed in conduit sized in accordance with the NEC. Conduit carrying a grounding conductor shall also be grounded at the earth electrode.

B. The earth electrode shall be:

1. The metallic domestic water piping system of the building. Connection of the grounding conductor shall be made by an approved grounding clamp. The point of connection to the water system shall be within 6 inches of the entrance of the pipe inside the building or structure. Where dielectric unions are used in the water piping system, the grounding connection shall be made on the “street side” of the first such union in the system. A bonding jumper the same wire size as the grounding conductor shall be installed across the water piping connection such that the water meter may be removed without interrupting the grounding system continuity. Where no metallic domestic water piping

system exists, the earth electrode shall be a ground rod with supplemental ground electrodes as defined below.

2. Ground Rods and Ground Ring: Size as specified below driven 11 feet into the earth where shown on the contract drawings or as required. The rod shall be connected to the system ground point as shown on the Drawings by an insulated, green copper jumper in conduit. The connection at the rod shall be brazed or exothermically welded. The points of connection to the earth electrode system shall be visible and accessible upon completion of construction. Sectional rods of the same size and length shall be used in multiple rod installations, if required by soil conditions.
3. The building steel and slab reinforcing steel as shown and as required by the NEC. Connection points shall be as directed by the Architect/Engineer.

1.3 PERFORMANCE REQUIREMENTS

The ground resistance of the earth electrode shall not exceed 25 ohms. The Electrical Contractor shall test the earth electrode using a standard three point ground resistance tester and shall advise the Architect/Engineer of the results of such tests in writing. Where tests show the resistance to ground exceeds 25 ohms, appropriate action shall be taken to reduce the resistance to 25 ohms, or less, by driving additional ground rods or other approved methods. Compliance shall be demonstrated by retesting.

1.4 ACTION SUBMITTALS

Product Data: For each type of product indicated.

1.5 SUBMITTALS FOR CLOSEOUT

A. Contract Closeout: Procedures for submittals as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Project Record Documents: Record actual locations of components and grounding electrodes.

C. Certificate of Compliance: Indicate approval of installation by authority having jurisdiction.

D. Test Reports: Indicates overall resistance to ground and resistance of each electrode.

1.6 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of Project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Burndy; Part of Hubbell Electrical Systems.

2. ERICO International Corporation.
3. O-Z/Gedney; a brand of Emerson Industrial Automation.

2.2 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.3 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors, tin plated:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

E. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

F. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

G. Conduit Hubs: Mechanical type, terminal with threaded hub.

H. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

I. Ground clamps shall not be fabricated from aluminum or any aluminum alloy.

2.5 ROD ELECTRODES

A. Ground Rods: Copper-clad steel 3/4 inch by 10 feet. Minimum copper coating of 13 mils.

2.6 BONDING BUSHINGS

Bonding bushings shall be steel or malleable iron, insulated, threaded type, zinc plated for interior use and galvanized for exterior use. Provide with dual rated tin plated saddle for use with bonding conductors and resilient plastic insulation throat liner with 150°C rating molded on over the metallic stop. All bushings shall be third party testing agency approved and listed. Die cast zinc bushings are not acceptable.

2.7 GROUND ROD INSPECTION WELLS

A. Pedestrian Traffic Rated

1. Well Housing: 9-inch diameter High Density Polyethylene (HDPE), 10" minimum length. Static vertical load rating of 300 PSF minimum. Two knock out mouse holes for conductor entrance. Harger GAW910, nVent Erico T416B or approved equal.
2. Well cover: HDPE twist lock with locking bolt and the legend "GROUND" embossed on cover.

B. Vehicle Traffic Rated

1. Well Housing: 10-inch diameter reinforced concrete, 12" minimum length. Static vertical load rating of 20,000 PSF minimum. Two knock out mouse holes for conductor entrance.
2. Well cover: Bolt down cast iron with the legend "GROUND" embossed on cover.

2.8 GROUNDING BUSBARS

A. Electrical Power Grounding Busbars: Third party testing agency listed and labelled. Grounding busbars shall be provided for single point termination of power distribution system grounding and bonding conductors as shown on the Drawings. Grounding busbars shall be tin plated solid copper factory drilled with a NEMA hole size and pattern for termination of two hole lugs, quantity as required with 25% spare, and be of the minimum dimensions shown on the Drawings. Provide with 600V standoff insulators, stainless steel mounting brackets and stainless steel hardware. Provide clear Lexan cover over connections.

B. Telecommunications Grounding Busbars: Comply with TIA-607-C and BISCI Standards. Grounding busbars shall be provided for single point termination of telecommunications system grounding and bonding conductors as shown on the Drawings. Grounding busbars shall be tin plated solid copper factory drilled with a BISCI hole size and pattern for termination of two hole lugs, quantity as required with 25% spare, and be of the minimum dimensions shown on the Drawings. Provide with 600V standoff insulators, stainless steel mounting brackets and stainless steel hardware. Provide clear Lexan cover over connections.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install tinned bare copper conductor, No. 2/0 AWG minimum.

1. Bury at least 24 inches (600 mm) below grade.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Exothermically welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Exothermically welded connectors.

3.2 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

3.4 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

D. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

E. Metallic Fences: Comply with requirements of IEEE C2.

1. Grounding Conductor: Bare copper, not less than No. 8 AWG.
2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
3. Barbed Wire: Strands shall be bonded to the grounding conductor.

F. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.

1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch (6.3-by-100-by-300-mm) grounding bus.
3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.5 INSTALLATION

A. Quality Control: Manufacturer's instructions shall be followed as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

C. All connections to ground conductors shall be accessible for inspection and made with approved solderless connectors, brazed or bolted to the equipment or structure to be grounded. All contact surfaces shall be thoroughly cleaned before connections are made to insure good metal to metal contact.

D. Provide bonding to meet Regulatory Requirements.

E. Provide separate, insulated conductor within each feeder and branch circuit raceway.

F. Equipment Grounding Conductor: The raceway system shall not be relied on for ground continuity. A green grounding conductor, properly sized per the NEC shall be run in all raceways. Terminate each end on suitable lug, bus, or bushing. Exceptions are as follows:

1. Raceways for telecommunications.
2. Raceways for data.
3. Raceways for audio conductors.
4. Services.

G. Equipment grounding continuity shall be maintained through flexible conduit as required in previous sections.

H. All equipment housings and/or enclosures, and all non-current carrying metallic parts of electrical equipment, raceway systems, etc., shall be effectively and adequately bonded to ground.

I. Grounding type insulated bonding bushings and jumpers shall be provided where concentric, eccentric or over-sized knockouts are encountered. The jumpers shall be sized per the NEC.

J. All metallic raceways entering or leaving panelboards (branch circuits less than 30 amperes in lighting and appliance branch circuit panelboards excepted), switchboards, transfer switches, enclosed circuit breakers, safety switches, transformers, etc. shall be provided with insulated grounding and bonding bushings and each separate piece of raceway shall be individually bonded to the equipment ground bus or metallic enclosure, as applicable, by means of copper conductor sized in accordance with the National Electrical Code, Tables 250-66 for services and transformers and 250-122 for other circuits.

K. An equipment ground bus shall be installed in each panelboard for terminating equipment grounding conductors.

L. All wiring devices equipped with grounding connections shall be permanently and securely connected to the enclosure in which they are mounted with a copper grounding jumper.

M. The frame of all lighting fixtures shall be securely grounded to the equipment ground system with grounding conductors.

N. Provide grounding electrode conductor and connect to reinforcing steel in foundation footing where indicated. Bond reinforcing steel together.

O. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. Install rod electrodes at locations indicated. Install additional rod electrodes as required to achieve specified resistance to ground.

P. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

Q. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

R. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install jumper to bond across flexible duct connections to achieve continuity.

3.6 EXISTING WORK

A. As noted:

1. Modify existing grounding system as shown.
2. Extend existing grounding system using materials and methods specified.

3.7 LABELING

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for instruction signs. The label or its text shall be green.

B. Install labels at the telecommunications bonding conductor and grounding equalizer.

1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.8 FIELD QUALITY CONTROL

A. Quality Assurance: Field inspection, testing and adjusting as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Perform the following tests and inspections and prepare test reports:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Make tests at ground rods before any conductors are connected.

C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.

C. References:

1. NECA - National Electrical Contractors Association.
2. ANSI/NFPA 70 - National Electrical Code.

1.2 ACTION SUBMITTALS

A. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: For each type of product.

C. Shop Drawings: Signed and sealed by a qualified professional engineer. For fabrication and installation details for electrical hangers and support systems.

D. Delegated-Design Submittal: For hangers and supports for electrical systems.

1. Include design calculations and details of trapeze hangers and d.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For hangers and supports for electrical equipment and systems, accessories, and components, from manufacturer.

B. Welding certificates.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products.

B. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."
2. Component Importance Factor: 1.5.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Stainless Steel Slotted Support Systems: Comply with MFMA-4 factory-fabricated components for field assembly.
1. Manufacturers:
    a. Unistrut.
    b. B-line.
    c. Erico.
    d. Substitutions: As permitted in relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.
2. Material: Type 316 stainless steel or, or, with specific approval of the Architect/Engineer, equivalent materials protected from corrosion by factory applied coatings, paint and galvanizing.
3. Channel Width: 1-5/8 inches, or as required to carry load.
4. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
5. Channel Dimensions: Selected for applicable load criteria.

B. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.

E. E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Steel Structural Elements: Use beam clamps.
2. Concrete Surfaces: Use self drilling anchors and expansion anchors.
3. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts.
4. Solid Masonry Walls: Use expansion anchors.
5. Sheet Metal: Use sheet metal screws or bolts

6. Wood Elements: Use wood screws.

2.3 NON-PENETRATING ROOFTOP CONDUIT SUPPORTS

A. Rooftop supports for conduit shall be provided for installation without requiring roof penetrations, flashing, or damage to the roofing material. Support Bases shall be made of an engineered thermoplastic with appropriate additives for UV protection. All structural steel components shall be hot dipped galvanized. Provide hot dipped galvanized or stainless steel clamps, bolts, nuts, washers, and other devices as required for a complete system. Height- adjustable supports shall be used where necessary. The support shall have a continuous bottom surface to provide even load distribution and minimize point loading of the roof membrane. The support base shall have a radiused edge to enhance compatibility with roof membranes. The rooftop strut support shall provide a fixed-height mounting platform with a minimum of 4” or 6” off of the roof surface and a usable strut length of up to 6”, 10”, 16”, 24”, 30”, 36”, 42”, 48” or 60”. Provide lengths as required. The adjustable-height strut support shall allow elevations changes of up to 18” off of the roof and a usable strut length of up to 10” or 16”.

B. Locate supports as indicated on the Drawings and as specified herein, sized as required by loading conditions. Provide complete and adequate support of all conduit, whether or not all required devices are shown. The use of wood for supporting conduit is not permitted. Provide supports spaced so deflection of conduit does not exceed 1/240 of span. Consult manufacturer of existing roofing system as to the type of isolation pads required between the roof and support. Set isolation pads in adhesive as prescribed by manufacturer's instructions. Place supports on isolation pads as required.

2.4 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems unless requirements in this Section are stricter.

B. Comply with requirements for “Conduits for Electrical Systems” specified in Section 260533.13 and “Boxes and Covers for Electrical Systems” specified in Section 260533.16.

C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, PVC, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

D. Do not use powder actuated anchors.

E. Obtain permission from Architect/Engineer before drilling or cutting structural members.

F. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

G. Install surface mounted cabinets and panelboards with minimum of four anchors. In wet and damp locations use steel channel supports to stand cabinets and panelboards one inch (25 mm) off wall.

H. Conduits installed on the interior of exterior building walls shall be spaced away from the wall surface a minimum of 1/4 inch (65mm) using “clamp-backs” or struts.

I. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

J. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

3.2 SUPPORT INSTALLATION

A. Install products in accordance with manufacturer’s instructions.

B. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.

C. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.

D. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

E. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.

F. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

1 3.4 PAINTING

2 A. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-
3 repair paint to comply with ASTM A 780.

4 END OF SECTION 260529

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SECTION 260533.13 - CONDUITS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type EMT raceways and elbows.
2. Type ERMC raceways, elbows, couplings, and nipples.
3. Type FMC raceways.
4. Type IMC raceways.
5. Type LFNC raceways.
6. Type PVC raceways and fittings.
7. Fittings for conduit, tubing, and cable.
8. Joint compounds.
9. Solvent cements.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
2. Section 260519 "Low-Voltage for Electrical Power Conductors and Cables" specifies nonmetallic underground conduit with conductors (Type NUCC).
3. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
4. Section 260529 "Hangers and Supports for Electrical Systems" specifies conduit hangers and supports referenced by this Section.
5. Section 260533.16 “Boxes and Covers for Electrical Systems”
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels.
7. Section 271100 "Communications Equipment Room Fittings" specifies additional requirements for installation of conduits for communications cabling.

C. References:

1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
2. ANSI C80.3 - Electrical Metallic Tubing, Zinc Coated.
3. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
4. ANSI/NFPA 70 - National Electrical Code.
5. NECA “Standard of Installation”.
6. NEMA TC 2 - Schedule 40 and 80 PVC.
7. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

D. Abbreviations and Acronyms for Electrical Raceway Types:

1. EMT: Electrical metallic tubing.
2. ERMC: Electrical rigid metal conduit.
3. FMC: Flexible metal conduit.
4. IMC: Steel electrical intermediate metal conduit.

5. LFMC: Liquidtight flexible metal conduit.
6. LFNC: Liquidtight flexible nonmetallic conduit.
7. PVC: Rigid PVC conduit.

1.2 DESIGN REQUIREMENTS

A. Conduit Size: ANSI/NFPA 70.

1.3 ACTION SUBMITTALS

A. Submit under provisions of relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

1.5 PROJECT RECORD DOCUMENTS

A. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Accurately record actual routing of conduits larger than 2 inches (51 mm).

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle Products to site under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Accept conduit on site. Inspect for damage.

C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

D. Protect PVC conduit from sunlight.

1.7 PROJECT CONDITIONS

A. Verify that field measurements are as shown on Drawings.

B. Verify routing and termination locations of conduit prior to rough-in.

C. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Size: Conduit shall be sized in accordance with the latest edition of the NEC unless shown otherwise, with minimum conduit size of 3/4 inch. Flexible nonmetallic watertight ("sealtite") conduit in size ½ inch and larger are acceptable for motor, appliance and fixture connections provided green ground wire is installed (see Section 260526) and NEC is followed.

C. Service: Use only building wire in Schedule 40 PVC conduit or use Schedule 80 PVC conduit where exposed to physical damage.

D. Panelboard and Equipment Feeders: Use only building wire in Schedule 40 PVC conduit or use Schedule 80 PVC conduit where exposed to physical damage. Life Safety (LS) Distribution System Feeders must be installed horizontally in and/or under building slabs and vertically in rated walls and in ERMC-PVC where installed exposed.

E. Exposed Branch Circuits in Unfinished Dry Interior Locations: Use only building wire in Schedule 40 PVC conduit or use Schedule 80 PVC conduit where exposed to physical damage.

F. Branch Circuits concealed or exposed in Finished, Conditioned, Dry Interior Locations (only the locations scheduled in Table "Non-Corrosive Atmosphere Spaces" on Sheet E6.16): Use only building wire in ERMC, IMC, EMT or FMC.

G. Branch Circuits in Wet or Damp Interior Locations: Use only building wire in Schedule 40 PVC conduit or use Schedule 80 PVC conduit where exposed to physical damage.

H. Underground Installations: Use only building wire in Schedule 40 PVC conduit.

I. Wet or Damp Interior Locations: Use only building wire in Schedule 40 PVC conduit or use Schedule 80 PVC conduit where exposed to physical damage.

J. Exterior Locations: Use only building wire in Schedule 40 PVC conduit or use Schedule 80 PVC conduit where exposed to physical damage.

2.2 TYPE EMT RACEWAYS AND ELBOWS

A. Electrical Metal Tubing (EMT) and Elbows:

1. Description: ANSI C80.3; galvanized tubing.
2. Fittings and Conduit Bodies: ANSI/NEMA FB 1; steel or malleable iron, compression type, insulated throat.

2.3 TYPE ERMC RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Electrical Rigid Metal Conduit (ERMC), Elbows, Couplings, and Nipples:

1. Rigid Steel Conduit: ANSI C80.1.

2. Plastic-Coated Rigid Steel Conduit Type ERMC-PVC): ANSI C80.1, 40 mil PVC coating.
3. Fittings and Conduit Bodies: ANSI/NEMA FB 1; material to match conduit with zinc-plated steel or malleable iron fittings.

2.4 TYPE FMC RACEWAYS

A. Flexible Metal Conduit (FMC):

1. Description: Interlocked steel construction.
2. Fittings: ANSI/NEMA FB 1, steel.

2.5 TYPE IMC RACEWAYS

A. Intermediate Metal Conduit (IMC):

1. Rigid Steel Conduit: ANSI C80.1.

2.6 TYPE LFNC RACEWAYS

A. Liquidtight Flexible Nonmetallic Conduit (LFNC):

1. Description: Thermoplastic polyvinyl chloride (PVC) with smooth inside and outside surface.
2. Fittings: ANSI/NEMA FB 1, steel or nonmetallic type.

2.7 TYPE PVC RACEWAYS AND FITTINGS

A. Schedule 40 and 80 Rigid PVC Conduit (PVC-40/80) and Fittings:

1. Description: NEMA TC 2; Schedule 40/80 PVC.
2. Fittings and Conduit Bodies: NEMA TC 3.

2.8 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. Fittings for Type ERMC, Type IMC, Type PVC, FMC, and LFNC Raceways:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. UL CCN DWTT; including UL 514B.

2.9 JOINT COMPOUNDS

A. Electrically Conductive Corrosion-Resistant Compound for Threaded Conduit:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN FOIZ; including UL Subject 2419.

2.10 SOLVENT CEMENTS

A. Solvent Cements for Nonmetallic Duct Raceways and Fittings:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Solvent Cements: including UL 340.
b. Solvent Cement Compatibility with PVC Conduit Fittings: including UL 514B. Follow solvent manufacturer's published instructions.
c. Solvent Cement Compatibility with Rigid PVC Conduit: including UL 651. Follow solvent manufacturer's published instructions.

PART 3 - EXECUTION

3.1 INSTALLATION OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Commissioning of Active and Passive Fire Protection Features: NFPA 3 and NFPA 4.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Communications Work: BICSI N1.
6. Life Safety and Means of Egress Work: NFPA 101.
7. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
8. Type EMT: Article 358 of NFPA 70 and NECA NEIS 101 & 102.
9. Type ERMC and ERMC-PVC: Article 344 of NFPA 70 and NECA NEIS 101 & 102.
10. Type FMC: Article 348 of NFPA 70 and NECA NEIS 101 & 102.
11. Type IMC: Article 342 of NFPA 70 and NECA NEIS 101.
12. Type LFNC: Article 342 of NFPA 70 and NECA NEIS 111.
13. Type PVC: Article 356 of NFPA 70 and NECA NEIS 111.
14. Expansion Fittings: NEMA FB 2.40.
15. Consult the Architect/Engineer for resolution of conflicting requirements.

C. Circuiting is shown schematically. Exact routing of branch circuits may be varied to suit building construction; however, the combination of circuits within raceways and panelboard connections shall not be changed from those shown on the drawings.

D. Raceways shall be installed concealed in finished areas and exposed elsewhere. Exposed raceways shall be run parallel to, or at a right angle with the building walls. Route conduit installed above accessible ceilings parallel and perpendicular to walls.

E. EMT may be utilized as permitted by the NEC, with the following restrictions. EMT shall not be installed:

1. Any location outdoors, in direct contact with earth, or underground (in/below slab- on grade or in earth.
2. Indoors in wet or damp locations, or in concrete, cinderblocks or bricks.
3. Where exposed to severe corrosive influence and/or severe physical damage.
4. Encased in concrete.

F. Where any run of rigid conduit may change to a run of EMT or vice-versa, each change shall be made in a junction or outlet box with each conduit terminated separately therein. Rigid conduit to EMT (or vice-versa) adapters shall not be permitted.

G. Special Installation Techniques:

1. General Requirements for Installation of Raceways:
   a. Complete raceway installation before starting conductor installation.
   b. Arrange conduit to maintain headroom and present neat appearance.
   c. Maintain adequate clearance between conduit and piping.
   d. Maintain 12-inch (300 mm) clearance between conduit and surfaces with temperatures exceeding 104 degrees F (40 degrees C).
   e. Cut conduit square using saw or pipecutter and de-burr cut ends.
   f. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of 2 ft above finished floor.
   g. Install no more than equivalent of three 90-degree bends in conduit run except for control wiring conduits, for which no more than equivalent of two 90-degree fewer bends are permitted. Support within 12 inch of changes in direction.
   h. Make bends in raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.
   i. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
   j. Support conduit within 12 inch of enclosures to which attached.
   k. Install sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install sealing fittings in accordance with NFPA 70.
   l. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of raceways at the following points:

      1) Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
      2) Where an underground service raceway enters a building or structure.
      3) Conduit extending from interior to exterior of building.
      4) Conduit extending into pressurized raceway and equipment.
      5) Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
      6) Where otherwise required by NFPA 70.

   m. Do not install raceways or electrical items on "explosion-relief" walls or rotating equipment.
   n. Do not install conduits within 2 inch of the bottom side of a metal deck roof.
   o. Keep raceways at least 6 inch away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

p. Cut conduit perpendicular to the length. For conduits metric designator 53 (trade size 2) and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.

q. Install pull wires in empty raceways. Provide polypropylene or monofilament plastic line with not less than 200 lb tensile strength. Leave at least 12 inch of slack at both ends of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

r. Install raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.

1) Termination fittings with shoulders do not require two locknuts.

2) Bring conduit to shoulder of fittings; fasten securely.

s. Use conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

t. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.

u. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to metric designator 35 (trade size 1-1/4) and insulated throat metal bushings on metric designator 41 (trade size 1-1/2) and larger conduits terminated with locknuts.

2. Types EMT, ERMC, and FMC: Do not install aluminum raceways or fittings.

3. Types ERMC and IMC:

a. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound that maintains electrical conductivity to threads of raceway and fittings before making up joints. Follow compound manufacturer's published instructions.

4. Type ERMC-PVC:

a. Follow manufacturer's installation instructions for clamping, cutting, threading, bending, and assembly.

b. Provide PVC-coated sealing locknut for exposed male threads transitioning into female NPT threads that do not have sealing sleeves, including transitions from PVC couplings/female adapters to Type ERMC-PVC elbows in direct-burial applications. PVC-coated sealing locknuts must not be used in place of conduit hub. PVC-coated sealing locknut must cover exposed threads on Type ERMC-PVC raceway.

c. Coat field-cut threads on PVC-coated raceway with manufacturer-approved corrosion-preventing conductive compound prior to assembly.

5. Types FMC and LFNC:

a. Provide a maximum of 72 inch of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

6. Types PVC:

a. Do not install Type PVC conduit where ambient temperature exceeds 122 deg F. Conductor ratings must be limited to 75 deg C except where installed in a trench outside buildings with concrete encasement, where 90 deg C conductors are permitted.

b. Comply with manufacturer's published instructions for solvent welding and fittings.

c. Join joints with solvent cement in accordance with manufacturer's published instructions and allowed to cure before handling. Joints to be bent, pushed, or pulled must set for minimum 24 h after joining.

7. Raceways Embedded in Slabs:
   a. Run raceways larger than 1" parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place raceway close to slab support. Secure raceways to reinforcement at maximum 10 ft intervals.
   b. Arrange raceways to cross building expansion joints with expansion fittings at right angles to the joint.
   c. Arrange raceways to ensure that each is surrounded by minimum of 2 inch of concrete without voids.
   d. Do not embed threadless fittings in concrete unless locations have been specifically approved by Architect.

8. Raceway Terminations at Locations Subject to Moisture or Vibration:
   a. Provide insulating bushings to protect conductors, including conductors smaller than 4 AWG.

9. Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines.
   a. ERMC-PVC: Provide only fittings listed for use with this type of conduit. Patch and seal joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Provide sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
   b. EMT: Provide compression, steel fittings. Comply with NEMA FB 2.10.
   c. Flexible Conduit: Provide only fittings listed for use with flexible conduit type. Comply with NEMA FB 2.20.

10. Expansion-Joint Fittings:
   a. Install in runs of aboveground PVC that are located where environmental temperature change may exceed 30 deg F and that have straight-run length that exceeds 25 ft.
   b. Install type and quantity of fittings that accommodate temperature change listed for the following locations:
      1) Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
      2) Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
      3) Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
   c. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
   d. Install expansion fittings at locations where conduits cross building or structure expansion joints.
   e. Install expansion-joint fitting with position, mounting, and piston setting selected in accordance with manufacturer's published instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

11. Raceways Penetrating Rooms or Walls with Acoustical Requirements: Seal raceway openings on both sides of rooms or walls with acoustically rated putty or firestopping.

12. Identification: Provide labels for conduit assemblies, raceways, and associated electrical equipment. Identify conduit under provisions of Section 260553.
    a. Provide warning signs.

H. Interfaces with Other Work:

1. Firestop penetrations of fire-rated floor and wall assemblies.
2. Provide conduit hangers and supports.
3. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation specified under Division 7.

I. Provide suitable fittings to accommodate expansion and deflection where conduit crosses control and expansion joints.

J. Use suitable caps to protect installed conduit against entrance of dirt and moisture.

K. The raceway system shall not be relied on for grounding continuity. Ground and bond conduit under provisions of Section 260526.

L. The use of “LB’s” shall be limited where possible. Where necessary to use “LB’s” sized above 2 inch, mogul units shall be installed.

M. Grounding type insulated bonding bushings and jumpers shall be provided for metallic raceway where concentric, eccentric or over-sized knockouts are encountered. The jumpers shall be sized per the NEC.

N. Fasten conduit supports to building structure and surfaces under provisions of Section 260529.

O. Arrange supports to prevent misalignment during wiring installation.

P. Support metallic conduit using corrosion resistant coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers. Use corrosion resistant mounting hardware. See Specifications Section 260010, Para. 1.23 for additional requirements.

Q. Support exposed PVC raceways using stainless steel or non-metallic straps and stainless-steel mounting hardware. See Specifications Section 260010, Para. 1.23 for additional requirements.

R. Group related conduits; support using conduit rack. Construct rack using stainless steel channel; provide space on each for 25 percent additional conduits.

S. Do not support conduit with wire or perforated pipe straps to include ceil support wire. Remove wire used for temporary supports.

T. All metallic raceways entering or leaving panelboards (branch circuits less than 30 amperes in branch circuit panelboards excepted), switchboards, transfer switches, enclosed circuit breakers, safety switches, transformers, pull boxes, splice boxes, etc. shall be provided with insulated grounding and bonding bushings and each separate piece of raceway shall be individually bonded to the equipment ground bus or metallic enclosure, as applicable, by means of copper conductor sized in accordance with the National Electrical Code.

U. The term “fittings” includes couplings, connectors, offsets, LBs, conduit bodies, hubs, bushings, bonding bushings, etc.

V. No pressure cast (pot metal) fittings or conduit bodies shall be allowed.

W. Outlets, junction, taps, etc., on exposed rigid metal conduit shall be cast malleable iron conduit fittings or cast malleable metal boxes of the type and size appropriate for the location. Sheet steel outlet boxes shall not be permitted on exposed raceway runs except at or near a ceiling for interior construction.

1. Interior exposed raceway junction, switch, receptacle, and outlet boxes installed at or below 8 feet AFF/AFG shall be cast malleable type with hubs and cast, gasketed plates.
2. Exterior exposed raceway junction, switch, receptacle, and outlet boxes shall be cast malleable type with hubs and cast, gasketed plates.

X. EMT couplings and terminations shall be made utilizing zinc-plated, steel hexagonal compression connectors. No set screw or indented type fittings shall be utilized.

Y. Install nonmetallic conduit in accordance with manufacturer's instructions.

Z. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.

AA. PVC schedule 40 shall not be used exposed or concealed in gypsum walls, but may be used in CMU walls.

BB. IMC and GRC shall terminate with either a double locknut / bushing set, or in a threaded hub.

CC. Conduit couplings for IMC, GRC and PVC shall be in accordance with the NEC.

DD. The placement of conduit in floor slabs shall be thoroughly coordinated with the General Contractor to avoid conflicts with steel reinforcing bars, reductions in net concrete sections and floor penetrations.

EE. Route conduit in and under slab from point-to-point.

FF. Do not cross conduits in slab.

GG. Schedule 40 PVC may only be used in elevated floor slabs and in foundation slabs with prior written approval from the Structural Engineer. Minimum concrete cover shall be 3/4 inch at finished or formed surface and shall be 3 inches at concrete surface cast against earth or for slabs placed on-grade. Greater amounts of concrete cover shall be used in areas subject to damage or corrosion. Installed systems shall comply with the minimum requirements of ACI318 Chapter 6.

HH. Where underground or underslab service and feeder raceways are required to turn up into cabinets, equipment, etc., and on to poles, the elbow required and the stub-up out of the slab or earth shall be of Schedule 80 PVC.

II. Raceways run external to building foundation walls, with the exception of branch circuit raceways, shall be encased with a minimum of three (3) inches of concrete on all sides.

JJ. Service entrance raceways run inside building foundation walls shall be buried at least eighteen (18) inches below grade or encased with a minimum of three (3) inches of concrete on all sides. Concrete encasement shall extend to the service equipment for raceways exposed above grade in crawl spaces.

KK. Encased raceways shall be of a type approved by the NEC as "suitable for concrete encasement".

LL. Encased raceways shall have a minimum cover of eighteen (18) inches, except for raceways containing circuits with voltages above 600 volts, which shall have a minimum cover of thirty (30) inches.

MM. Branch circuit raceways run underground external to building foundation walls shall be run in raceways installed in accordance with the NEC, and shall be of a type approved by the NEC as “suitable for direct burial.” Minimum raceway size shall be 1 inch.

NN. Raceways run underground, internal to building foundation walls shall be of a type, and installed by a method approved by the NEC.

OO. Raceways that penetrate outside walls, ceilings from conditioned space or other similar condition shall be effectively sealed to prevent condensation from infiltrating humid air.

PP. Where raceways pass through a below grade wall, from a conditioned interior building space, the raceway shall be sealed utilizing fittings similar and equal to OZ/GEDNEY type “FSK” thru-wall fitting with “FSKA” membrane clamp adapter if required.

QQ. All underground raceways shall be identified by underground line marking tape within the provisions of Section 260553. The tape to be located directly above the raceway and 6 to 8 inches below finished grade.

RR. EMT conduit provided below roof deck shall be installed 11/2 inches away from the deck to allow for screws not to penetrate the EMT conduit during reroofing.

SS. Conduits, JBs, Troughs, any enclosure when mounted outside on the walls, shall be off the walls by one inch.

TT. Surface metal raceways shall be used only where indicated on the drawings. All hardware and supports shall be per NEC and supplied by with raceway.

UU. Surface Raceways:

1. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

3.2 INTERFACE WITH OTHER PRODUCTS

A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods under the provisions of Division 7.

B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation specified under Division 7.

3.3 FIELD QUALITY CONTROL OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.

2. Pull solid aluminum or wood test mandrel through raceway to prove joint integrity and adequate bend radii, and test for out-of-round raceway. Provide minimum 12 inch long mandrel equal to raceway size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.
3. Conduit Placement:
    a. Verify that center-line location and offsets are in accordance with the Drawings.
    b. Verify that hangers and supports for conduits are attached to structure in accordance with the Drawings.
    c. Verify that nuts on bolts or hanger rods are secure.
    d. Verify that space between raceways and cored holes are filled with non-shrinking grout or other approved material indicated on the Drawings and the Specifications.
    e. Verify that expansion devices are installed at locations indicated on the Drawings and the Specifications.
    f. Verify that ends are cut square to provide flush-butting surfaces when spliced and inside edges are free of burrs that could impede installation of cables.
    g. Verify minimum separation of utilities, or that approved mechanical protection has been provided to surrounding conduit(s) where minimum separation cannot be achieved.
4. Document all changes on Record Drawings.

B. Nonconforming Work:

1. Conduit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

C. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.4 CLEANING

A. Verify that bentonite or other drilling fluids are contained and removed, and site is restored to its original or improved condition.

3.5 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533.13

SECTION 260533.16 - BOXES AND COVERS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metallic outlet boxes, device boxes, rings, and covers.
2. Nonmetallic outlet boxes, device boxes, rings, and covers.
3. Junction boxes and pull boxes.
4. Cover plates for device boxes.
5. Hoods for outlet boxes.
6. Fire Rated Poke-Throughs

B. Related Requirements:

1. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
2. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
3. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.
4. Section 262726 “Wiring Devices” for boxes and covers.

C. References:

1. NECA - Standard of Installation.
2. NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies.
3. NEMA OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
4. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
5. NFPA 70 - National Electrical Code.

1.2 DEFINITIONS

A. Communications Outlet: One or more communications jacks, or cables and plugs, mounted in a box or ring, with a suitable protective cover.

B. Enclosure: The case or housing of an apparatus, or the fence or wall(s) surrounding an installation, to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage. When writing specification requirements and drawing notes, remember that "receptacle outlets" include boxes and covers; "receptacles" do not.

C. Receptacle: A fixed connecting device arranged for insertion of a power cord plug. Also called a power jack.

D. Receptacle Outlet: One or more receptacles mounted in a box with a suitable protective cover.

1.3 ACTION SUBMITTALS

A. Submittals: Procedures for submittals. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: For each type of product, provide manufacturer's catalog information showing dimensions and configurations.

C. Shop Drawings: Prepare and submit the following:

1. Shop Drawings for Floor Boxes: Show that floor boxes are located to avoid interferences and are structurally allowable.

1.4 CLOSEOUT SUBMITTALS

A. Record actual locations and mounting heights of outlet, pull, and junction boxes on project record documents.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 METALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

A. Metallic Outlet Boxes and Covers: NEMA OS.1, galvanized steel

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Appleton; Emerson Electric Co., Automation Solutions.
b. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
c. Spring City Electrical Manufacturing Company.

2. Junction, switch, receptacle and outlet boxes for interior use in finished, conditioned, dry locations shall be zinc coated or cadmium plated sheet steel, 4" square and 2-1/8" deep, unless otherwise indicated on the contract drawings. Smaller and shallower outlet boxes will be permitted only by special permission of the Architect/Engineer where such boxes are necessary due to structural conditions encountered. Where larger junction boxes are required, they shall be fabricated from No. 10, 12, 14 or 16 gauge sheet steel as required by the Underwriters Laboratories, Inc., and galvanized after fabrication. All junction boxes shall have screw fastened covers. Outlet boxes shall be provided with extension plaster rings where required by structural and finish conditions.

3. Standard Features:
a. Box having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for entrance of conduit, conduit or cable fittings, or

cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly to box.

4. Other Available Features Required by the Project:
   a. Luminaire Outlet Boxes and Covers: Nonadjustable, listed and labeled for attachment of luminaire weighing up to 50 lb; include 2 inch (13 mm) male fixture studs where required.
   b. Paddle Fan Outlet Boxes and Covers: Nonadjustable, designed for attachment of paddle fan weighing up to 70 lb.
   c. Wall Plates for Finished Areas: As specified in Section 262726.

B. Cast Boxes: NEMA FB 1, Type FD, cast feralloy.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Appleton; Emerson Electric Co., Automation Solutions.
   b. Crouse-Hinds; brand of Eaton, Electrical Sector.
   c. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
2. Provide gasketed cover by box manufacturer.
3. Provide threaded hubs.

C. Metallic Conduit Bodies, Device Boxes, and Extension Rings:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
   a. UL CCN QCIT; including UL 514A.

3. Standard Features: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.

2.3 NONMETALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

A. Nonmetallic Outlet Boxes and Covers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cantex Inc.
   b. Carlon.
   c. Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated.

2. Where specifically noted, outlet boxes may be non-metallic type complying with NEMA OS 1 and UL 514A, and designed for use with nonmetallic sheathed cable.
3. Standard Features: Box having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly to box.

B. Nonmetallic Conduit Bodies, Device Boxes, and Extension Rings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cantex Inc.
   b. Carlon.

c. Hubbell.

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. UL CCN QCMZ; including UL 514C.

3. Standard Features: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.

2.4 JUNCTION BOXES AND PULL BOXES

A. Indoor Sheet Metal Junction and Pull Boxes:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Appleton; Emerson Electric Co., Automation Solutions.
b. Cooper B-line; brand of Eaton, Electrical Sector.
c. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
a. UL CCN BGUZ; including UL 50 and UL 50E.

3. Standard Features:
a. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
b. PVC with PVC covers and stainless steel hardware.
c. Box with a blank cover that serves the purpose of joining different runs of raceway or cable.

B. Outdoor Non-metallic Junction and Pull Boxes:
1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
a. UL CCN BGUZ; including UL 50 and UL 50E.

2. Standard Features:
a. Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
b. Degree of Protection: Type 4X.

2.5 COVER PLATES FOR DEVICE BOXES

A. Metallic Cover Plates for Device Boxes:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
   a. UL CCN QCIT or UL CCN QCMZ; including UL 514D.

2. Standard Features:
   a. Cover plate-Securing Screws: Metal with head color to match cover plate finish.
   b. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
   c. Cover Plate Material: 0.032 inch thick, Type 302/304 non-magnetic stainless steel with brushed finish.

2.6 HOODS FOR OUTLET BOXES

A. Retractable or Reattachable Hoods for Outlet Boxes:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
   a. UL CCN QCIT or UL CCN QCMZ; including UL 514D.
   b. Receptacle, Hood, Cover Plate, Gaskets, and Seals: UL 498 Supplement SA when mated with box or enclosure complying with UL 514A, UL 514C, or UL 50E.

2. Standard Features:
   a. Mounts to box using fasteners different from wiring device.
   b. Provides clear, weatherproof, "while-in-use" cover.

B. Extra-Duty, While-in-Use Hoods for Outlet Boxes:

1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
   a. UL CCN QCIT or UL CCN QCMZ; including UL 514D.
   b. Receptacle, Hood, Cover Plate, Gaskets, and Seals: UL 498 Supplement SA when mated with box or enclosure complying with UL 514A, UL 514C, or UL 50E.

2. Standard Features:
   a. Mounts to box using fasteners different from wiring device.
   b. Marked "Extra-Duty" in accordance with UL 514D.
   c. Provides clear, weatherproof, "while-in-use" cover.
   d. Manufacturer may combine nonmetallic device box with hood as extra-duty rated assembly.

PART 3 - EXECUTION

3.1 EXAMINATION

Verify locations of outlets prior to rough-in.

3.2 SELECTION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of boxes and enclosures. Consult Architect for resolution of conflicting requirements.

B. Degree of Protection:

1. Outdoors:

a. Type 4 unless otherwise indicated.

2. Indoors:

a. Type 4 unless otherwise indicated.

C. Exposed Boxes Installed Less Than 2.5 m (8 ft) Above Floor:

1. Provide non-metallic boxes.
2. Provide exposed cover. Flat covers with angled mounting slots or knockouts are prohibited.

3.3 INSTALLATION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Commissioning of Active and Passive Fire Protection Features: NFPA 3 and NFPA 4.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Communications Work: BICSI N1.
6. Life Safety and Means of Egress Work: NFPA 101.
7. Emergency and Standby Power Work: NFPA 110, NFPA 111, and NECA NEIS 416.
8. Work in Confined Spaces: NFPA 350.
9. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
10. Outlet, Device, Pull, and Junction Boxes: Article 314 of NFPA 70.
11. Consult Architect for resolution of conflicting requirements.

C. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.

D. Special Installation Techniques:

1. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.
2. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements.
3. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat

surface for a raintight connection between box and cover plate or supported equipment and box, whether installed indoors or outdoors.

4. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
5. Locate boxes so that cover or plate will not span different building finishes.
6. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.
7. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for purpose.
8. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
9. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.
10. Boxes and Enclosures in Areas or Walls with Acoustical Requirements:

    a. Seal openings and knockouts in back and sides of boxes and enclosures with acoustically rated putty.
    b. Provide gaskets for cover plates and covers.

11. Set wall mounted boxes at elevations to accommodate mounting heights indicated and specified in section for outlet device. Boxes are shown on Drawings in approximate locations unless dimensioned. Adjust box location up to 10 feet if required to accommodate intended purpose. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only. Install boxes to preserve fire resistance rating of partitions and other elements, using approved materials and methods. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes. Use flush mounting outlet box in finished areas. Use Erico Caddy RBS series, Raco 9001 or Cooper B-Line BB8-16 box mounting brackets to support flush mounting outlet boxes between studs.

E. Interfaces with Other Work:

1. Identification: Provide labels for boxes and associated electrical equipment.

    a. Identify field-installed conductors, interconnecting wiring, and components.
    b. Label each enclosure with engraved metal or laminated-plastic nameplate.
    c. Provide warning signs and arc-flash hazard warning labels for electrical equipment.

3.4 ADJUSTING

A. Contract Closeout: Adjust installed work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Adjust floor box and poke-throughs flush with finish flooring material.

C. Adjust flush-mounting outlets to make flush with finished wall material.

D. Install knockouts closures in unused box openings.

3.5 CLEANING

A. Contract Closeout: Clean installed work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Remove construction dust and debris from interior of boxes before installing cover plates, covers, and hoods.

C. Clean exposed surfaces and restore finish.

3.6 PROTECTION

A. After installation, protect boxes from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 260533.16

SECTION 260533.23 - SURFACE RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Surface metal raceways and fittings.
2. Surface nonmetallic raceways.
3. Wireways and auxiliary gutters.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
2. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
3. Section 260553 "Identification for Electrical Systems" specifies warning signs referenced by this Section.
4. Section 271100 "Communications Equipment Room Fittings" specifies additional requirements for identification of communications equipment and cabling.

C. References:

1. NECA “Standard of Installation”.
2. NFPA 70 - National Electrical Code.
3. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
4. UL 5 - Surface Metal Raceways and Fittings; Current Edition, Including All Revisions.
5. UL 94, V-0 requirements for self-extinguishing characteristics.
6. UL 111 - Outline of Investigation for Multioutlet Assemblies; Current Edition, Including All Revisions.
7. UL 870 - Wireways, Auxiliary Gutters, and Associated Fittings; Current Edition, Including All Revisions.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 SURFACE METAL RACEWAYS AND FITTINGS

2.3 SURFACE NONMETALLIC RACEWAYS

A. Surface Nonmetallic Raceways and Fittings with Nonmetallic Covers:
   1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
      a. UL CCN RJTX; including UL 5A.
      b. UL 94, V-0 requirements for self-extinguishing characteristics.
   2. Standard Features:
      a. Provide texture and color selected by Architect from manufacturer's standard colors.
      b. Wiring Channels: Multiple channels must be capable of housing a standard 20 to 30 A device flush within the raceway.

2.4 WIREWAYS AND AUXILIARY GUTTERS

A. Nonmetallic Wireways and Auxiliary Gutters:
   1. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
      a. UL CCN ZOYX; including UL 870.
      b. UL 94, V-0 requirements for self-extinguishing characteristics.
   2. Standard Features:
      a. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings must match and mate with wireways as required for complete system.
      b. PVC Solvents and Adhesives: As recommended by wireway manufacturer.
      c. Material:
         1) Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover must be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections must be flanged and have stainless steel screws and oil-resistant gaskets.
         2) PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURFACE RACEWAYS FOR ELECTRICAL SYSTEMS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
4. Communications Work: BICSI N1.
5. Work in Confined Spaces: NFPA 350.
6. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
7. Auxiliary Gutters: Article 366 of NFPA 70.
8. Surface Metal Raceway: Article 386 of NFPA 70.
9. Surface Nonmetallic Raceway: Article 388 of NFPA 70.
10. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Install surface raceways only where indicated on Drawings.
2. Install surface raceway with a minimum 2 inch radius control at bend points.
3. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inch and with no less than two supports per straight raceway section. Support surface raceway in accordance with manufacturer's published instructions. Tape and glue are unacceptable support methods.

3.2 FIELD QUALITY CONTROL OF SURFACE RACEWAYS

A. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Perform tests and inspections recommended by standards listed in "Reference Standards for Installation" Paragraph.

B. Nonconforming Work:

1. Boxes and covers will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

C. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.3 CLEANING

A. Remove construction dust and debris from surface raceways before installing covers.

3.4 PROTECTION

A. After installation, protect surface raceways from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 260533.23

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Round sleeves.
2. Rectangular sleeves.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.
6. Pourable sealants.
7. Foam sealants.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ROUND SLEEVES

A. Steel Wall Sleeves:

1. General Characteristics: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.

B. Cast-Iron Wall Sleeves:

1. General Characteristics: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.

C. PVC Pipe Sleeves:

1. General Characteristics: ASTM D1785, Schedule 40.

D. PVC Molded Sleeves:

1. General Characteristics: With nailing flange for attaching to wooden forms.

E. PE or PP Molded Sleeves:

1. General Characteristics: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Round, Galvanized-Steel, Sheet Metal Sleeves:

1. General Characteristics: Galvanized-steel sheet; thickness not less than 0.0239 inch; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

2.2 RECTANGULAR SLEEVES

A. Rectangular, Galvanized-Steel, Sheet Metal Sleeves:
   1. General Characteristics:
      a. Material: Galvanized sheet steel.
      b. Minimum Metal Thickness:
         1) For sleeve cross-section rectangle perimeter less than 50 inch and with no side larger than 16 inch, thickness must be 0.052 inch.
         2) For sleeve cross-section rectangle perimeter not less than 50 inch or with one or more sides larger than 16 inch, thickness must be 0.138 inch.

2.3 SLEEVE-SEAL SYSTEMS

A. General Characteristics: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable or between raceway and cable.

B. Options:

1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

A. General Characteristics: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit must have plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

A. General Characteristics: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
2. Design Mix: 5000 psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.6 POURABLE SEALANTS

A. Performance Criteria:

1. General Characteristics: Single-component, neutral-curing elastomeric sealants of grade indicated below.

a. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

2.7 FOAM SEALANTS

A. Performance Criteria:

1. General Characteristics: Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam. Foam expansion must not damage cables or crack penetrated structure.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
b. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4 inch annular clear space between sleeve and raceway or cable, unless sleeve-seal system is to be installed or seismic criteria require different clearance.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inch above finished floor level. Install sleeves during erection of floors.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for wall assemblies.

C. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

D. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve-seal systems. Size sleeves to allow for 1 inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

E. Underground, Exterior-Wall and Floor Penetrations:

1. Install steel pipe sleeves with integral waterstops. Size sleeves to allow for 1 inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Install sleeve during construction of floor or wall.
2. Install steel pipe sleeves. Size sleeves to allow for 1 inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Grout sleeve into wall or floor opening.

3.2 INSTALLATION OF RECTANGULAR SLEEVES AND SLEEVE SEALS

A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.

B. Install conduits and cable with no crossings within the sleeve.

C. Fill opening around conduits and cables with expanding foam without leaving voids.

D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

3.3 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

END OF SECTION 260544

SECTION 260548 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vibration controls.
2. Seismic and wind controls.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
2. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers and supports referenced by this Section.

1.2 DEFINITIONS

A. Designated Seismic System: An architectural, electrical, or mechanical system and its components for which the component importance factor is greater than 1.0.

1.3 DELEGATED DESIGN SERVICES

A. Delegated Design Professionals: Engage qualified structural professional engineer to design seismic and wind controls.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Prepare and submit catalog cuts, brochures, diagrams, schedules, and performance data illustrating size, physical appearance, and other characteristics of product.

    a. Include rated load capacity for each seismic- and wind-restraint device.
    b. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic- and wind-restraint component used.
    c. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by an agency acceptable to authorities having jurisdiction.
    d. Annotate to indicate application of each product submitted and compliance with requirements.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.

2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
3. Show coordination of seismic and wind bracing for components with other systems and equipment in the vicinity, including other supports and seismic restraints.

C. Delegated Design Submittals:

1. For each seismic-restraint device, including restraint - rigid and cable type, restraint accessory, and concrete anchor and insert that is required by this Section or is indicated on the Drawings, submit the following:

    a. Seismic Restraints: Select seismic restraints complying with performance requirements, design criteria, and analysis data.
    b. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated seismic criteria. Include certification that device is approved by qualified testing laboratory for seismic reinforcement use.
    c. Seismic Design Calculations: Submit input data and loading calculations.

2. For each wind-restraint device, including restraint - rigid and cable type, restraint accessory, and concrete anchor and insert that is required by this Section or is indicated on the Drawings, submit the following:

    a. Wind Restraint: Select wind restraints complying with performance requirements, design criteria, and analysis data.
    b. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated wind criteria. Include certification that device is approved by qualified testing laboratory for reinforcement use.
    c. Wind Design Calculations: Submit static and dynamic loading calculations.

3. Seismic- and Wind-Restraint Detail Drawings:

    a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
    b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
    c. Coordinate seismic-restraint details with wind details required for equipment mounted outdoors.

4. Product Listing, Preapproval, and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

D. Field quality-control reports.

1.5 REGULATORY AGENCY APPROVALS

A. Delegated design submittals and shop drawings requiring approval by authorities having jurisdiction must be signed by qualified structural professional engineer responsible for their preparation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Prepare design calculations in accordance with criteria specified in Section 260010 "Supplemental Requirements for Electrical".

B. Seismic and Wind Restraint Device Ratings: Devices must be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices must be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: an agency acceptable to authorities having jurisdiction.

C. Consequential Damage: Provide additional seismic and wind restraints for suspended components or anchorage of floor-, roof-, or wall-mounted components so that failure of a non-essential or essential component will not cause failure of any other essential building component.

D. Fire/Smoke Resistance: Seismic- and wind-restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by qualified testing laboratory in accordance with ASTM E84 or UL 723, and be so labeled.

E. Component Supports:

1. Load ratings, features, and applications of reinforcement components must be based on testing standards of qualified testing laboratory.

2.2 VIBRATION CONTROLS

A. Elastomeric Isolation Pads:
1. Standard Features:

a. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
b. Size: Factory or field cut to match requirements of supported equipment.
c. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
d. Surface Pattern: Smooth, ribbed, or waffle pattern.
e. Infused nonwoven cotton or synthetic fibers.
f. Load-bearing metal plates adhered to pads.
g. Sandwich-Core Material: Resilient and elastomeric.

1) Surface Pattern: Smooth, ribbed, or waffle pattern.
2) Infused nonwoven cotton or synthetic fibers.

2.3 SEISMIC AND WIND CONTROLS

A. Restraints - Rigid Type:
1. Standard Features: Shop- or field-fabricated bracing assembly made of ANSI/AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to

building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

B. Restraints - Cable Type:
1. Standard Features:

a. Seismic- and Wind-Restraint Cables: ASTM A492 stainless steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic-restraining cable service; with fittings attached by means of poured socket, swaged socket, or mechanical (Flemish eye) loop.
b. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19. Cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

C. Restraint Accessories:
1. Standard Features:

a. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections and/or reinforcing steel angle clamped to hanger rod. Non-metallic stiffeners are unacceptable.
b. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
c. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
d. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
e. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

D. Mechanical Anchor Bolts:
1. Standard Features:

a. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.
b. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
c. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

E. Adhesive Anchor Bolts:
1. Standard Features

a. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.
b. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
c. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

F. Concrete Inserts:
1. Standard Features:

a. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC446 testing.
b. Comply with MSS SP-58.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive seismic and wind control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF VIBRATION AND SEISMIC CONTROLS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install where indicated or scheduled on the Drawings to receive them and where required to prevent buckling of hanger rods caused by seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry static, wind, and seismic loads within specified loading limits.

3.3 INSTALLATION OF SEISMIC AND WIND CONTROLS

A. Provide seismic and wind control devices for systems and equipment where indicated in Equipment Schedules or Seismic and Wind Controls Schedule, where indicated on the Drawings, where the Specifications indicate they must be installed on specific equipment and systems, and where required by applicable codes.

1. Install equipment and devices to withstand the effects of earthquake motions and high wind events.

B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

C. Installation of seismic and wind restraints must not cause any stresses, misalignment, or change of position of equipment or conduits.

D. Equipment Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
2. Install seismic-restraint and wind-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

E. Raceway, Cable, Wireway, Cable Tray, and Busway Support and Hanger Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
2. Install seismic-restraint and wind-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
3. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
4. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

F. Install cables so they do not bend across edges of adjacent equipment or building structure.

G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

H. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

I. Post-Installed Concrete Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors must be installed with sleeve fully engaged in the structural element to which anchor will be fastened.
4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque using a torque wrench.
6. Install stainless-steel anchors for interior and exterior applications.

J. Accommodation of Differential Seismic Motion: Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.4 FIELD QUALITY CONTROL

A. Field tests must be witnessed by Architect.

B. Special Structural Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test no fewer than four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.

C. Nonconforming Work:

1. Seismic controls will be considered defective if they do not pass tests and inspections.
2. Remove and replace malfunctioning units and retest as specified above.

D. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

END OF SECTION 260548

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SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Nameplates and Labels.
2. Wire and cable markers.
3. Conduit markers.
4. Wiring device plates marking.
5. Underground warning tape.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
2. Division 9: Finishes – Painting.

C. References:

ANSI/NFPA 70 - National Electrical Code.

1.2 ACTION SUBMITTALS

A. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: Provide catalog data for nameplates, labels, and markers.

C. Identification Schedule: For each piece of electrical equipment and electrical system components to be index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

D. Manufacturer’s Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation and installation of Product.

PART 2 - PRODUCTS

2.1 NAMEPLATES AND LABELS

A. Nameplates: Engraved three-layer laminated plastic as follows:

Furnish and install engraved laminated phenolic nameplates for all electrical equipment supplied under this contract for identification of system, equipment controlled or served, phase, voltage, ampacity, fault current, etc. Nameplates shall be securely attached to equipment with

stainless steel screws, and shall identify by name the equipment controlled, attached, etc. Embossed, self-adhesive plastic tape is not acceptable for marking equipment. Nameplate material colors shall be:

1. Blue surface with white core for all 120/208 volt equipment.
2. Black surface with white core for 277/480 volt equipment.
3. Bright red surface with white core for all equipment related to fire alarm system.
4. Dark red (burgundy) surface with white core for all equipment related to Security.
5. Green surface with white core for all equipment related to “emergency” systems.
6. Orange surface with white core for all equipment related to telephone systems.
7. Brown surface with white core for all equipment related to data systems.
8. White surface with black core for all equipment related to paging systems.
9. Purple surface with white core for all equipment related to TV systems.

B. Locations:

1. Each electrical distribution and control equipment enclosure (safety switches, panelboards, transformers, etc.)
2. Communication cabinets.
3. Pull and splice boxes.

C. Letter Size: Letters shall be a minimum of 1/2 inch (13 mm) high.

D. See details on the Drawings for additional requirements.

E. Provide nameplates as specified above for all existing electrical equipment to remain.

2.2 WIRE MARKERS

A. Description: Split sleeve type wire markers or approved equivalent.

B. Locations: Each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection.

C. Legend:

1. Power and Lighting Circuits: Branch circuit or feeder number as indicated on drawings.
2. Control Circuits: Control wire number as indicated on schematic and interconnection diagrams on drawings.

2.3 CONDUIT, RACEWAY AND BOX MARKING

Paint visible surfaces of exposed junction and outlet boxes and covers of raceway systems above lay-in and other accessible ceilings. Paint all boxes and covers before installation. Paint conduit and raceways above accessible ceilings at ten foot minimum intervals with a 6 inch wide band in accordance with the color scheme outlined above. Legibly mark conduits at junction boxes above accessible ceilings with the panelboard and circuit numbers of the circuits contained in the raceway using a permanent black, bold marking pen.

2.4 WIRING DEVICE PLATES MARKING

A. Description: Adhesive backed, laminated plastic receptacle device plate labels identifying the circuit feeding the device. Labels shall be label machine printed, black lettering on a clear background, to indicate panel and circuit number and shall be Casio, Brother, T&B or approved equal.

B. Locations: Each receptacle device plate. Apply centered on the lower portion below the receptacle, parallel to the lower surface.

C. Legend: Typed labels to indicate panel and circuit number feeding the device (i.e., RPA-24).

2.5 UNDERGROUND WARNING TAPE

6 inch wide, 4 mils thick, minimum, permanent plastic tape compounded for direct burial, detectable type, colored bright yellow with suitable continuous warning legend describing buried electrical lines.

PART 3 - EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 APPLICATION

A. Install nameplate parallel to equipment lines.

B. Secure nameplate to equipment front using stainless steel rivets or stainless steel machine screws, lockwashers and acorn nuts as shown on the Drawings. Stainless steel screws and nylon locknuts may be used in lieu of lockwashers and acorn nuts if the screw threads are not exposed.

C. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

D. Install receptacle circuit identification labels.

E. Identify conduit using field painting under provisions of Division 9.

F. All empty conduit runs and conduit with conductors for future use shall be identified for use and shall indicate where they terminate. Identification shall be by tags with string or wire attached to conduit or outlet.

G. Update all existing panelboard directories where changes are made. Provide new panel schedule cards as required to maintain legibility.

H. Identify underground conduits using one underground warning tape per trench at 6 - 8 inches below finished grade.

I. Install adhesive backed labels only when ambient temperature and humidity conditions for adhesive use are within range recommended by manufacturer.

END OF SECTION 260553

SECTION 260573 - POWER SYSTEM STUDIES

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section Includes:

1. Short-circuit study.
2. Overcurrent protective device coordination study.
3. Load-flow and voltage-drop study.
4. Arc-flash hazard study.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.

1.2 ACTION SUBMITTALS

A. Product Data: For power system analysis software to be used for studies.

1. Product Certificates: For power system study software applications, include certificate stating compliance with specified requirements, signed by software manufacturer.

B. Power System Study Reports:

1. Submit reports after approval of system protective devices submittals. Submittal may be in digital form.
2. Submit short-circuit study input data, including completed computer-program input data sheets.
3. Submit coordination study input data, including completed computer-program input data sheets.

    a. Submit load-flow, and voltage-drop data with coordination study.

4. Submit arc-flash study input data, including completed computer-program input data sheets.
5. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
6. Submit revised one-line diagram, reflecting field investigation results and results of short-circuit study.

C. Data files for studies in format compatible with Owner's power system analysis software.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For coordination-study specialist.

B. Product Certificates: For coordination study and fault current study computer software programs, certifying compliance with IEEE 399.

1.4 QUALITY ASSURANCE

A. Submittals for power system studies must be signed and sealed by qualified electrical professional engineer responsible for their preparation.

B. Studies must be performed using commercially developed and distributed software designed specifically for power system analysis.

C. Software algorithms must comply with requirements of standards and guides specified in this Section.

D. Manual calculations are unacceptable.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. EDSA Micro Corporation.
2. EasyPower; brand of Bentley Systems, Inc.
3. Power Tools for Windows (PTW); brand of SKM Systems Analysis, Inc.

B. Standard Features:

1. Power System Analysis:

a. Power-systems-analysis software applications must have analytical capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 3002 series standards.
b. Computer software application must be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program must report device settings and ratings of overcurrent protective devices and must demonstrate selective coordination by computer-generated, time-current coordination plots.
c. Computer software application must be designed to perform arc-flash analysis or have function, component, or add-on module designed to perform arc-flash analysis.

2. Analysis Standards:

a. Short-Circuit Current Analysis: In accordance with IEEE 3002.3.
b. Device Coordination Analysis: In accordance with IEEE 3004.3 and IEEE 3004.5.
c. Load-Flow Analysis: In accordance with IEEE 3002.2.

d. Harmonic Analysis: In accordance with IEEE 3002.8.
e. Transient Stability Analysis: In accordance with IEEE P3002.9.
f. Arc-Flash Hazard Analysis: In accordance with IEEE 1584.

3. Capable of printing arc-flash hazard warnings for equipment on vinyl, weather- and UV-resistant, pressure-sensitive adhesive labels complying with NFPA 70E.

a. Label must have orange header with wording, "WARNING, ARC-FLASH HAZARD," and must include the following information taken directly from arc-flash hazard study:

1) Equipment designation.
2) Nominal voltage.
3) Protection boundaries.

a) Arc-flash boundary.
b) Restricted approach boundary.
c) Limited approach boundary.

4) Arc-flash PPE category.
5) Required minimum arc rating of PPE in Cal/cm squared.
6) Available incident energy.
7) Working distance.
8) Engineering report number, revision number, and issue date.

C. Other Available Features Required by the Project:

1. Simultaneous faults.
2. Explicit negative sequence.
3. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Collect and analyze data for power system studies.

1. Verify completeness of data supplied in one-line diagram on Drawings. Call discrepancies to Architect's attention.
2. For equipment included as Work on the Project, use characteristics submitted under provisions of action submittals and information submittals for the Project.
3. For relocated equipment and equipment that is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers in accordance with NFPA 70E.
4. Gather and tabulate required input data to support power system studies. Comply with requirements in Section 017839 "Project Record Documents" for recording circuit protective device characteristics. Record data on Record Document copy of one-line diagram. Comply with recommendations in IEEE 3002 series standards as to amount of detail that is required to be acquired in field. Field data gathering must be by, or under supervision of, qualified electrical professional engineer. Data include, but are not limited to, the following:

a. Product data for the Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
b. Electrical power utility impedance at service.
c. Power sources and ties.
d. Short-circuit current at each system bus (three phase and line to ground).
e. Full-load current of loads.
f. Voltage level at each bus.
g. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
h. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
i. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
j. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
k. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
l. Maximum demands from service meters.
m. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
n. Motor horsepower and NEMA MG 1 code letter designation.
o. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
p. Medium-voltage cable sizes, lengths, conductor material, cable construction, metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).
q. Derating factors.

3.2 PREPARATION

A. Preparation of Data for Short-Circuit Study:

1. Verify completeness of data supplied on one-line diagram. Call discrepancies to Architect's attention.
2. For equipment included as Work on the Project, use characteristics submitted under provisions of action submittals and information submittals for the Project.
3. Prepare one-line diagram of modeled power system, showing the following:

a. Protective device designations and ampere ratings.
b. Conductor types, sizes, and lengths.
c. Transformer kVA and voltage ratings.
d. Motor and generator designations and kVA ratings.
e. Switchboard, motor-control center, and panelboard designations and ratings.
f. Derating factors and environmental conditions.
g. Revisions to electrical equipment required by study.

B. Preparation of Data for Overcurrent Protective Device Coordination Study:

1. Prepare data sheets to supplement electrical distribution system one-line diagram, cross-referenced with tag numbers on diagram, indicating the following:

a. Special load considerations, including starting inrush currents and frequent starting and stopping.
b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
d. Generator thermal-damage curve.
e. Ratings, types, and settings of utility company's overcurrent protective devices.
f. Special overcurrent protective device settings or types stipulated by utility company.
g. Time-current-characteristic curves of devices indicated to be coordinated.
h. Manufacturer, frame size, interrupting rating in amperes root mean square (rms) symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
j. Switchboards, motor-control centers, and panelboards ampacity, and SCCR in amperes rms symmetrical.
k. Identify series-rated interrupting devices for condition where available fault current is greater than interrupting rating of downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

2. Examine the Project's overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance of the Work. Devices to be coordinated are indicated on Drawings.
3. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

C. Preparation of Data for Arc-Flash Hazard Study:

1. Assemble data from short-circuit study and overcurrent protective device coordination study.
2. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.3 SHORT-CIRCUIT STUDY

A. Base study on device characteristics supplied by device manufacturer.

B. Extent of electrical power system to be studied is indicated on Drawings.

C. Study the electrical distribution system, beginning at the utility transformer, from normal and alternate power sources throughout electrical distribution system for the Project. Study cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

D. Include AC fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase AC systems. Also account for fault-current DC decrement to address asymmetrical requirements of interrupting equipment.

E. Calculate short-circuit momentary and interrupting duties for three-phase bolted fault and single line-to-ground fault at equipment indicated on one-line diagram.

1. For grounded systems, provide bolted line-to-ground fault-current study for areas as defined for three-phase bolted fault short-circuit study.

F. Include in report identification of protective device applied outside its capacity.

3.4 OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

A. Base study on device characteristics supplied by device manufacturer.

B. Study the electrical distribution system, beginning at the utility transformer, from normal and alternate power sources throughout electrical distribution system for the Project. Study cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. See the Evaluations for discussion of what data should be indicated on one-line diagram, where the study should stop, and what data should be obtained and verified by Contractor.

D. Transformer Primary Overcurrent Protective Devices:

1. Device must not operate in response to the following:

   a. Inrush current when first energized.
   b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
   c. Permissible transformer overloads in accordance with IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings must protect transformers in accordance with IEEE C57.12.00, for fault currents.

E. Motor Protection:

1. Select protection for low-voltage motors in accordance with IEEE 3004.8 and NFPA 70.
2. Select protection for motors served at voltages more than 600 V in accordance with IEEE 620.

F. Conductor Protection: Protect cables against damage from fault currents in accordance with ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 3004.7. Demonstrate that equipment withstands maximum short-circuit current for time equivalent to tripping time of primary relay protection or total clearing time of fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

G. Generator Protection: Select protection in accordance with manufacturer's published instructions and IEEE C37.102.

H. Include AC fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase AC systems. Also account for fault-current DC decrement, to address asymmetrical requirements of interrupting equipment.

I. Include coordination of ground-fault protection devices.

J. Calculate short-circuit momentary and interrupting duties for three-phase bolted fault and single line-to-ground fault at equipment indicated on one-line diagram.

1. For grounded systems, provide bolted line-to-ground fault-current study for areas as defined for three-phase bolted fault short-circuit study.

K. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.
2. Adequacy of switchboards, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
3. Application of series-rated devices must be recertified, complying with requirements in NFPA 70.
4. Include in report identification of protective device applied outside its capacity.

3.5 LOAD-FLOW AND VOLTAGE-DROP STUDY

A. Perform load-flow and voltage-drop study to determine steady-state loading profile of system. Analyze power system performance two times as follows:

1. Determine load flow and voltage drop based on full-load currents.
2. Determine load flow and voltage drop based on 80 percent of design capacity of load buses.
3. Prepare load-flow and voltage-drop analysis and report to show power system components that are overloaded, or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

3.6 ARC-FLASH HAZARD STUDY

A. Comply with NFPA 70E, including Annex D, for arc-flash hazard study.

B. Preparatory Studies: Obtain short-circuit study and overcurrent protective device coordination study results prior to starting arc-flash hazard study.

C. Calculate maximum and minimum contributions of fault-current size.

1. Maximum calculation must assume maximum contribution from utility and must assume motors to be operating under full-load conditions.
2. Calculate arc-flash energy at 85 percent of maximum short-circuit current in accordance with IEEE 1584 recommendations.
3. Calculate arc-flash energy at 38 percent of maximum short-circuit current in accordance with NFPA 70E recommendations.
4. Calculate arc-flash energy with utility contribution at minimum and assume no motor contribution.

D. Calculate arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.

E. Include low-voltage equipment locations.

F. Calculate limited, restricted, and prohibited approach boundaries for each location.

G. Incident energy calculations must consider accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations must account for changing current contributions, as sources are interrupted or decremented with time. Fault contribution from motors and generators must be decremented as follows:

1. Fault contribution from induction motors must not be considered beyond three to five cycles.
2. Fault contribution from synchronous motors and generators must be decayed to match actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 p.u. to 3 p.u. after 10 cycles).

H. Arc-flash energy must generally be reported for maximum of line or load side of circuit breaker. However, arc-flash computation must be performed and reported for both line and load side of circuit breaker as follows:

1. When circuit breaker is in separate enclosure.
2. When line terminals of circuit breaker are separate from work location.

I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.7 POWER SYSTEM STUDY REPORTS

A. Preparation of Power System Study Reports: Prepare and submit the following:

1. Short-Circuit Study Report Contents:

a. Executive summary of study findings.
b. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
c. One-line diagram of modeled power system, showing the following:

1) Protective device designations and ampere ratings.
2) Conductor types, sizes, and lengths.
3) Transformer kVA and voltage ratings.
4) Motor and generator designations and kVA ratings.
5) Switchboard, motor-control center, and panelboard designations and ratings.
6) Derating factors and environmental conditions.
7) Revisions to electrical equipment required by study.

d. Comments and recommendations for system improvements or revisions in written document, separate from one-line diagram.
e. Short-Circuit Study Input Data:

1) One-line diagram of system being studied.
2) Power sources available.
3) Manufacturer, model, and interrupting rating of protective devices.
4) Conductors.
5) Transformer data.

f. Protective Device Evaluation:

1) Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstand ratings exceed available short-circuit current at equipment installation locations.
2) Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
3) For 600 V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
4) For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
5) Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

g. Short-Circuit Study Output Reports:

1) Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a) Voltage.
b) Calculated fault-current magnitude and angle.
c) Fault-point X/R ratio.
d) Equivalent impedance.

2) Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a) Voltage.
b) Calculated symmetrical fault-current magnitude and angle.
c) Fault-point X/R ratio.
d) Calculated asymmetrical fault currents based on fault-point X/R ratio; based on calculated symmetrical value multiplied by 1.6; and based on calculated symmetrical value multiplied by 2.7.

3) Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a) Voltage.
b) Calculated symmetrical fault-current magnitude and angle.
c) Fault-point X/R ratio.
d) No AC Decrement (NACD) ratio.
e) Equivalent impedance.
f) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on symmetrical basis.
g) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.

2. Overcurrent Protection Device Coordination Study Report Contents:

a. Executive summary of study findings.
b. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
c. One-line diagram of modeled power system, showing the following:

1) Protective device designations and ampere ratings.
2) Conductor types, sizes, and lengths.
3) Transformer kVA and voltage ratings.
4) Motor and generator designations and kVA ratings.
5) Switchboard, motor-control center, and panelboard designations.
6) Revisions to electrical equipment required by study.

d. Report recommended settings of protective devices, ready to be applied in field. Use manufacturer's data sheets for recording recommended setting of overcurrent protective devices when available.

1) Phase and Ground Relays:

a) Device tag.
b) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
c) Recommendations on improved relaying systems, if applicable.

2) Circuit Breakers:

a) Adjustable pickups and time delays (long time, short time, and ground).
b) Adjustable time-current characteristic.
c) Adjustable instantaneous pickup.
d) Recommendations on improved trip systems, if applicable.

3) Fuses: Show current rating, voltage, and class.

e. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for switching schemes and for emergency periods where power source is local generation. Show the following information:

1) Device tag and title, one-line diagram with legend identifying portion of system covered.
2) Terminate device characteristic curves at point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
3) Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4) Plot the following listed characteristic curves, as applicable:

a) Power utility's overcurrent protective device.
b) Medium-voltage equipment overcurrent relays.
c) Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
d) Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
e) Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
f) Cables and conductors damage curves.
g) Ground-fault protective devices.
h) Motor-starting characteristics and motor damage points.

i) Generator short-circuit decrement curve and generator damage point.
j) Largest feeder circuit breaker in each motor-control center and panelboard.

5) Maintain selectivity for tripping currents caused by overloads.
6) Maintain maximum achievable selectivity for tripping currents caused by overloads on series-rated devices.
7) Provide adequate time margins between device characteristics such that selective operation is achieved.
8) Comments and recommendations for system improvements.

3. Arc-Flash Hazard Study Report Contents:

a. Executive summary of study findings.
b. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
c. One-line diagram, showing the following:

1) Protective device designations and ampere ratings.
2) Conductor types, sizes, and lengths.
3) Transformer kVA and voltage ratings, including derating factors and environmental conditions.
4) Motor and generator designations and kVA ratings.
5) Switchboard, motor-control center, panelboard designations, and ratings.

d. Short-circuit study output data.
e. Overcurrent protective device coordination study report contents.
f. Arc-Flash Study Output Reports:

1) Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in report:

a) Voltage.
b) Calculated symmetrical fault-current magnitude and angle.
c) Fault-point X/R ratio.
d) No AC Decrement (NACD) ratio.
e) Equivalent impedance.
f) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on symmetrical basis.
g) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.

g. Incident Energy and Flash Protection Boundary Calculations:

1) Arcing fault magnitude.
2) Protective device clearing time.
3) Duration of arc.
4) Arc-flash boundary.
5) Restricted approach boundary.
6) Limited approach boundary.
7) Working distance.
8) Incident energy.
9) Hazard risk category.
10) Recommendations for arc-flash energy reduction.

h. Fault study input data, case descriptions, and fault-current calculations including definition of terms and guide for interpretation of computer printout.

3.8 FIELD ADJUSTMENT FOR DEVICE COORDINATION

A. Adjust relay and protective device settings in accordance with recommended settings provided by coordination study. Field adjustments must be completed by engineering service division of equipment manufacturer under "Startup and Acceptance Testing" contract portion.

B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.

C. Testing and adjusting must be by qualified low-voltage electrical testing and inspecting agency.

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for adjustable overcurrent protective devices.

3.9 WARNING LABELING OF ARC-FLASH HAZARDS

A. Apply arc-flash label on front cover of each section of equipment for each equipment included in study, including each piece of equipment listed below:
1. Switchboards.
2. Panelboards.
3. Motor Control Centers.
4. Low voltage transformers.
5. Automatic Transfer Switches.
6. Safety switches.
7. Control panels.
8. Motor starters.

B. Base arc-flash label data on highest values calculated at each location.

C. Machine print warning labels with no handwritten or field-applied markings.

D. Install arc-flash warning labels under direct supervision and control of qualified electrical professional engineer.

E. Indicate on record Drawings location of equipment where personnel could be exposed to arc-flash hazard during their work.

1. Indicate arc-flash energy.
2. Indicate protection level required.

END OF SECTION 260573

SECTION 260580 - EQUIPMENT WIRING SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

Electrical power supply for, and connections to, equipment specified under other Divisions and/or provided by the Owner or Owner's vendors.

1.2 RELATED DIVISIONS AND SECTIONS

NOTE: Work specified to be accomplished by Division 26 in Related Divisions and Sections shall be as binding as work specified in Division 26.

A. Division 1: Owner-furnished equipment.

B. Division 11: Equipment.

C. Division 13: Special Construction.

D. Division 14: Conveying Systems.

E. Division 17: Life Support Systems

F. Division 21: Fire Suppression.

G. Division 22: Plumbing.

H. Division 23: Heating, Ventilating and Air Conditioning.

I. Section 260533 – Conduit.

J. Section 260519 - Building Wire and Cable.

K. Section 260534 – Boxes.

L. Section 260526 - Grounding and Bonding.

M. Section 260553 - Electrical Identification.

N. Section 260923 – Network Lighting Controls.

O. Section 265101 – Architectural Interior Light Fixtures.

1.3 REFERENCES

A. NEMA WD 1 - General Purpose Wiring Devices.

B. NEMA WD 6 - Wiring Device Configurations.

C. ANSI/NFPA 70 - National Electrical Code.

1.4 SUBMITTALS

A. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.5 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Where electrical wiring is required by trades other than covered by Division 26, specifications for that section shall refer to same wiring materials and methods as specified under Division 26.

1.6 COORDINATION

A. Coordinate work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Obtain and review shop drawings, product data, and manufacturer's instructions for equipment furnished under other sections.

C. Determine connection locations and requirements.

D. Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.

E. Sequence electrical connections to coordinate with start-up schedule for equipment.

PART 2 - PRODUCTS

2.1 CORDS AND CAPS

A. Attachment Plug Construction: Conform to NEMA WD 1.

B. Configuration: NEMA WD 6; match receptacle configuration at outlet provided for equipment.

C. Cord Construction: ANSI/NFPA 70, Type SO multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.

D. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify conditions under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 ELECTRICAL WORK IN CONNECTION WITH OTHERS

A. Division 26 shall provide a source of power, and final connections, for mechanical, plumbing, sprinkler, food service, elevator, Life Support Systems, General Contractor-furnished and Owner-furnished equipment shown on the Drawings. Provide pigtails, flexible connections, conductors, raceways, circuit breakers, safety switches, receptacles, junction boxes, panelboards, wiring troughs, etc. as detailed in this section and/or as shown on the Drawings.

B. The locations of safety switches and other electrical equipment and devices shown on the Electrical Drawings are approximate only and some adjustment of their locations should be anticipated. Coordinate exact locations with the entity (contractor or Owner) providing the equipment. See other specifications divisions for further explanation of contractor responsibility. Do not apply power to equipment without the permission of the entity providing the equipment.

C. Division 26 shall coordinate with the mechanical, plumbing, sprinkler, food service, elevator, life support systems and general contractors, and the Owner, prior to ordering or installation of any equipment, to verify equipment requirements are provided in the electrical design. Coordinate and verify all electrical requirements, final connections, phasing and rotation, overcurrent and overload protective device sizes with the entity providing the equipment. The contractor will not be compensated for costs associated with changing the electrical systems to match utilization equipment, even if the electrical work is installed per the electrical drawings.

D. Fuses, control devices and sensors and control wiring and control raceways will be provided and installed by the entity providing the equipment. The locations of local disconnecting means furnished by other divisions are shown on the respective division's Drawings. Coordinate exact locations with the entity providing the equipment.

E. Variable frequency drives, magnetic motor starters, combination starters, starter overload elements, etc. will be provided as noted below.

F. Division 17 Life Support Systems (LSS) Equipment.

1. Division 26 shall furnish and install power wiring, and final connections, to equipment provided by Division 17. If the equipment requires an external motor starter, variable frequency drive, etc., Division 26 will provide and install the starter, VFD, etc. and wire complete. If the equipment has built-in disconnects and motor starters, Division 26 shall make final connections to the disconnects. Circuit breaker and motor starter and VFD ratings shall be coordinated with Division 17. Refer to Sheets LS0.02 – LS0.06 for Division 17 electrical requirements. Division 26 shall make final connections to the equipment. See Electrical Drawings for additional detail.
3. LSS Automation Control Panels: Division 26 shall provide and install 120V power wiring to the control panel(s) terminals or to receptacle(s), as required. See LSS Drawings for details.
4. Division 26 shall provide raceways and conductors for Division 17 control circuits. See LSS Automated Controls Points List and Wiring Types on Sheet LS0.09.
5. Refer to Division 17 for additional detail concerning electrical connections to Division 17 equipment.

G. Division 23 (Mechanical) Equipment.

1. Division 26 shall furnish and install power wiring, and final connections, to equipment provided by Division 23. If the equipment is provided with an external motor starter, variable frequency drive, etc., Division 23 will provide and install the starter, VFD, etc. and Division 26 shall wire complete. If the equipment has built-in disconnects, Division 26 shall make final connections to the disconnects. If shown

on the Drawings, Division 26 shall provide circuit breakers in adjacent panelboards, where allowed by Code and equipment requirements, in lieu of safety switches, to serve local mechanical equipment. Circuit breaker ratings shall be coordinated with Division 23. Division 26 shall make final connections to the equipment.

2. HVAC Control Panels, Control Equipment and Computers:
   a. Division 26 shall provide and install 120V power wiring to the control panel(s) terminals or to receptacle(s), as required. Division 26 shall provide sufficient electrical circuits from the fire alarm control panel to enable all required mechanical equipment operations during fire mode. See Division 23 Specifications for further definition of the required fire alarm/mechanical control system interface and operation sequence and coordinate with Division 23.
   b. HVAC Control and Miscellaneous Power: Division 26 shall provide branch circuit power sources (designated "HVAC Control Power" 20A circuit breakers in selected branch circuit panelboards) as indicated in the panel schedules on the Drawings. Division 23 shall extend power from these circuit breakers as required for control power, damper power, and power for unscheduled HVAC equipment. If additional circuits are required, the contractor may use circuit breakers designated as "Spare".
   c. All control and similar equipment less than 120VAC including fuses, relays, actuators, timers, seven-day clocks, alternators, pressure, vacuum, float and flow sensors, pneumatic-electric and low voltage thermostats, thermal overloads, remote selector switches, remote pushbutton stations, emergency break-glass stations, interlocking, etc. and other appurtenances associated with equipment in Division 23, shall be furnished, installed and wired under Division 23. All wiring required for controls and instrumentation, not indicated on the Drawings, shall be furnished and installed by Division 23.
3. Heat Tape: Division 26 shall provide junction boxes or weatherproof, ground fault equipment circuit breakers and electrical connection for heat tapes. See the Drawings for locations and confirm exact locations and termination requirements with Division 23.
4. Duct Mounted Smoke Detectors: Duct mounted smoke detectors shall be provided and wired by Division 26, but installed by Division 23. Fire Alarm Air Handling Units (AHU) shut down circuits shall be wired, by Division 26, from the fire alarm control panel to a termination point, adjacent to the AHU. Division 26 shall leave sufficient marked conductor tails in a junction box adjacent to each unit for final connection by Division 23 to the equipment. Duct mounted smoke detectors are shown on the mechanical floor plans only.
6. Refer to Division 23 for additional detail concerning electrical connections to Division 23 equipment.

F. Division 22 (Plumbing) Equipment:
1. Division 26 shall furnish and install a properly sized fused safety switch, and make final power connections for each item of equipment specified in Division 22 and as shown on the Drawings.
2. All control and similar equipment less than 120VAC including fuses, relays, actuators, timers, seven-day clocks, alternators, pressure, vacuum, float and flow sensors, pneumatic-electric and low voltage thermostats, thermal overloads, remote selector switches, remote pushbutton stations, emergency break-glass stations, interlocking, etc. and other appurtenances associated with equipment in Division 22, shall be furnished, installed and wired under Division 22. All wiring required for controls and instrumentation, not indicated on the Drawings, shall be furnished and installed by Division 23.
3. Electric Water Heaters: Division 26 shall furnish and install a fusible safety switch adjacent to each water heater and shall make final power connections to the water heater.

4. Domestic Water Booster Pumps: Division 22 will furnish and install an automatic motor control system for the pump system skid. Division 26 shall wire to the control system complete.
5. Hot Water Circulation Pump: Division 22 will furnish and install a manual motor starter for circulator pump. Division 26 shall wire the system complete.
6. Electric Water Coolers: Division 26 shall provide grounding type 120VAC GFCI receptacle(s), quantity as required by the equipment, for 120VAC power supply at each electric water cooler and shall consult with Division 22 and determine the exact location and type service required for each type installed before roughing in. All outlets and cords shall be concealed within the cabinet.
7. Refer to Division 22 for additional detail concerning electrical connections to Division 22 equipment.

G. Division 14 (Elevator) Equipment:
1. Division 26 shall provide a power source for all elevator equipment including elevator controllers and elevator cab lighting. Furnish and install a properly sized fusible safety switch, adjacent to the respective equipment or in locations as required by the elevator manufacturer, and make final power connections for each item of equipment specified in Division 14 and as shown on the Drawings. Provide connections as required and coordinate exact locations and configurations with the General Contractor and the elevator vendor.
2. Division 26 shall also provide raceways for telephone connections, and telephone cable to the telephone backboard if specified, to each elevator controller.
3. The electrical design for the elevator(s) is based on the elevator specified in Division 14. The Contractor shall compensate the electrical engineer for any and all required modifications to the electrical design required by alternate elevator electrical requirements. Modifications to the electrical requirements shall be provided by the Contractor at no additional cost to the Owner.
4. Provide fire alarm system connections to the elevator controllers and provide appropriate signals to the controllers during fire mode, including recall and fire hat signals. Coordinate requirements with the Division 14. See Specs Section 283111 for additional requirements.
5. Provide power for elevator sump pumps, control panels and alarm systems as required. Provide connections as required and coordinate exact locations and configurations with the General Contractor and Division 14.
6. Provide accessory power and lighting as required by Division 14.
7. Provide shunt trip accessory for all feeder circuit breakers supplying elevator controllers, if required. Coordinate shut trip coil voltage. Provide electrical supervision for shunt trip circuits as indicated and as required by Codes. See Drawings and Specifications Section 283111 for control requirements and details.

H. Division 21 (Fire Protection) System: Division 26 shall connect fire alarm system conductors to sprinkler flow and tamper switches, provided and installed by Division 21. Final connections shall be made by Division 26 under the direct supervision of Division 21. See Fire Alarm System Drawings and Specifications Section 283111 for interface requirements and details.

J. Food Service Equipment: Division 26 shall provide a power source adjacent to equipment provided by the Food Service Equipment Vendor and make final electrical connections to the equipment. See Food Service Equipment Drawings, Specifications and Food Service Equipment Electrical Notes on the Drawings for additional details and requirements. Coordinate exact locations and requirements with the Food Service Equipment Vendor and the General Contractor. Do not apply power to equipment without the permission of the Food Service Equipment Vendor.

K. General Contractor Provided Equipment: Division 26 shall provide a power source adjacent to equipment provided by the General Contractor. Final connections to this equipment shall be provided by Division 26. Coordinate exact locations and requirements with the General Contractor.

1. Door Hold-Open Devices: Division 26 shall furnish and install electrical connections from the fire alarm system to each door hold-open device, furnished by the General Contractor, at locations as shown and as directed by the General Contractor. Provide connections as required and coordinate exact locations and configurations with the General Contractor and the door hardware vendor. Final connections to the equipment shall be by Division 26 in cooperation with the General Contractor.
2. Electrically-Operated Doors: Division 26 shall furnish and install a power supply to each electrically-operated door at locations as shown and as directed by the General Contractor. Division 26 shall also install and wire door activation switches provided by the General Contractor. Provide connections as required and coordinate exact locations and configurations with the General Contractor and the door hardware vendor. Final connections to the equipment shall be by Division 26 in cooperation with the General Contractor.
3. Projection Screens: Division 26 shall furnish and install a junction box and disconnect switch adjacent to each projection screen and make power connections to the screen power terminals. Division 26 shall also install and wire screen position switches provided by the General Contractor. Provide connections as required and coordinate exact locations and configurations with the General Contractor and the projection screen vendor. Final connections to the equipment shall be by Division 26 in cooperation with the General Contractor.

L. Owner Provided Equipment: Division 26 shall provide a power source adjacent to equipment provided by the Owner. Coordinate exact locations and requirements with the General Contractor. Final connection to the equipment will be provided by Division 26. Provide receptacle configurations and/or provide direct connection as required by equipment and coordinate exact locations and configurations with the Owner. Do not apply power to equipment without the permission of the Owner.

O. Lighting Consultant's lighting fixtures and controls. See Specifications Sections 260923 and 265101 and Drawings Sheets LT-*** for details and required Division 26 work.

P. A/V Systems Equipment: Division 26 shall provide boxes, raceways and power for Owner-provided and installed A/V equipment. Coordinate exact locations and requirements with the Owner and the A/V Systems contractor. Final connection to the equipment will be provided by Division 26 in coordination with the A/V Systems contractor. Provide receptacle configurations as required and coordinate exact locations and configurations with the A/V Systems contractor. Do not apply power to equipment without the permission of the A/V Systems contractor.

3.3 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer's instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.

C. Make wiring connections using wire and cable with insulation suitable for temperatures encountered in heat producing equipment.

D. Provide receptacle outlet where connection with attachment plug is indicated. Provide cord and cap where field-supplied attachment plug is indicated.

E. Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

F. Provide interconnecting conduit and wiring between devices and equipment where indicated.

END OF SECTION 260580

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SECTION 260900 – POWER CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Power Controls.
   1. Power control enclosures (ERP).

1.2 RELATED SECTIONS

A. Section 26 27 16 - Electrical Cabinets and Enclosures.

B. Section 26 09 43 - Network Lighting Controls.

C. Section 41 67 19 - Plant Safety Equipment. Building integrator shall provide integration of the lighting control system with Building Automation Systems.

1.3 SUBMITTALS

A. Submit under provisions of Section 01 30 00.

B. Product Data:
   1. Manufacturer's data sheets on each product to be used.
   2. Preparation instructions and recommendations.
   3. Storage and handling requirements and recommendations.
   4. Typical installation methods.

C. Shop Drawings: Include details of materials, construction, and finish. Include relationship with adjacent construction.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with a minimum five years documented experience.

B. Installer Qualifications: Company specializing in performing Work of this section with minimum two years documented experience with projects of similar scope and complexity.

C. Source Limitations: Provide each type of product from a single manufacturing source to ensure uniformity.

1.5 PRE-INSTALLATION CONFERENCE

A. Convene a conference approximately two weeks before scheduled commencement of the Work. Attendees shall include Architect, Contractor and trades involved. Agenda shall include schedule, responsibilities, critical path items and approvals.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store and handle in strict compliance with manufacturer's written instructions and recommendations.

B. Protect from damage due to weather, excessive temperature, and construction operations.

1.7 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under

environmental conditions outside manufacturer's recommended limits.

1.8 WARRANTY

A. Manufacturer's standard limited warranty unless indicated otherwise.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: ETC Inc, which is located at: 3031 Pleasant View Rd., P. O. Box 620979; Middleton, WI 53562-0979; Phone: 608-831-4116; Email:mail@etcconnect.com; Web:www.etcconnect.com.

B. Substitutions: Not permitted.

C. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00.

2.2 POWER CONTROL ENCLOSURES

A. Echo Relay Panel Mains Feed (ERP) by ETC Inc. Control-oriented power center. Supports up to 24 relays or dimmers with integral branch breakers. Integrated DMX and Ethernet connectivity. Optional 0-10 V, DALI, and contact input control cards. UL 924 listed for emergency lighting control.
    1. Construction: Steel, 16 ga.
        a. Finish: Black, fine-textured, scratch-resistant powder coat.
        b. Flush-Mount Door: Extends 1 inch beyond all panel edges to hide wall cutout.
        c. Removable Outer Panel: Includes integral locking door to limit access to electronics, breakers, and local relay overrides.
        d. Full Front Access: No side clearance required.
        e. Removable Covers: For access to Class 1 and 2 wiring.
    2. Thermal:
        a. Operating Temperature: 32 to 104 degrees F (0 to 40 degrees C).
        b. Humidity: 10 to 90 percent, non-condensing.
    3. Electrical:
        a. Main Feed Power Input:
            1) Power: Single-Phase 3-Wire Plus Ground: 120/240 V.
            2) Power: Three-Phase 4-Wire Plus Ground: 120/208 V.
        b. Separate Wiring Chambers: For Class 1 and Class 2 terminations.
        c. Max Input Current: 200 Amps.
        d. Main Circuit Breaker: 100 or 200 Amps.
        e. Branch Breaker Panel: Supports 3-phase or 1-phase sub-feed of a second panel up to 100 Amps.
        f. Short-Circuit Rating: 10,000 to 42,000 Amps symmetrical.
        g. Branch Circuit Breakers: 1, 2, or 3 pole. 10, 15, and 20 A. Rating: 80 percent.
        h. GFCI Branch Circuit Breakers: 1 or 2 pole. 120 V. 15 or 20 A.
        i. Inrush-pulse tolerance: 8 to 10.5 times rated current for half-cycle at 60 Hz.
    4. Power Control Cards:
        a. ERP 1PR: Single-pole, 20 A relay card.
        b. ERP 2PR: Two-pole, 20 A relay card.
        c. ERP 3PR: Three-pole, 20 A relay card.
        d. ERP-DIM: Single-pole, 300 W phase-adaptive dimmer card.
        e. ERP-DIM-MLV: Single-pole, 300 W forward-phase dimmer card.
    5. Relay Ratings:
        a. Ballast (HID): 20 A.
        b. Electronic Ballast: 16 A.

c. Tungsten: 20 A.
d. Motor Load: 20 A.
e. Isolation: 4000 V RMS.
f. State: Latching; mechanically held.
g. Life: 100,000 cycles at full resistive load.
h. Life: 30,000 cycles motor, inductive, or tungsten.
i. Current-Reporting Accuracy: Plus or minus 5 percent of connected load.

6. Dimmer Ratings:
   a. ERP-DIM:Phase-adaptive (default reverse-phase), 300 W resistive or electronic load capacity.
   b. ERP-DIM-MLV: Forward-phase, 300 W magnetic or resistive load capacity.
7. Control:
   a. User interface:
      1) Graphical display with LED backlight.
      2) Button Interface With: 0 to 9 number buttons.
      3) Navigation Buttons: Up, down, back and enter.
      4) "Light bulb" test button for local preset activation, sequence and set level overrides.
      5) USB interface: For upload of setup and software updates.
   b. Control Wiring Terminations:
      1) Control Terminals: Accept 12 AWG wire.
      2) Control Wiring Exiting Panel: Class 2.
      3) Control Terminations: Utilize removable connectors.
   c. Relay Modes: Normal (priority/HTP), latch-lock or last-action.
   d. Configurable DMX on/off threshold.
   e. Status feedback for breaker state, relay state, current drawer circuit, phase voltage and energy usage per circuit.
   f. Presets and sequences:
      1) Sixteen spaces with 64 presets per space configurable via local UI.
      2) One 16 step sequence per space.
   g. UL924 Listed emergency control bypass.
   h. Configurable Data-Loss Behavior: Play preset; Hold last look; Wait and fade.
8. Accessories:
   a. Dimming 0-10 V: 24 outputs of 0-10 V sink dimming control rated for 100 mA per output.
   b. Contact Input: 24 dry contact inputs used to:
      1) Trigger Presets and Sequences: Play at priority configured for architectural sources.
      2) Directly Control of One or More Outputs. Priority of outputs is configurable. If no configuration, the last action takes precedence.
   c. DALI Control Loops: 24 broadcast DALI controls. Each loop supports 64 ballasts. External DALI power supply required.
   d. RideThru Option: Short-term power backup of control electronics.
      1) Automatically engages when power is lost.
      2) Recharges during normal power operation.
   e. Tamper-Proof Hardware Kit: Special screw heads prevent access to panel interior.
9. Standards Compliance: Listed: cULus, UL508, UL67, and UL924. ANSI E1.11 DMX512-A and ANSI E1.31 streaming ACN.
10. Quantities and configurations of Echo Relay Panel Mains Feed enclosures, power control cards, and accessories to be supplied as shown on project drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly constructed and prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect in writing of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions, approved submittals, and in proper relationship with adjacent construction.

3.4 FIELD QUALITY CONTROL

A. Field Inspection: Coordinate field inspection in accordance with appropriate sections in Division 01.

B. Manufacturer's Services: Coordinate manufacturer's services in accordance with appropriate sections in Division 01.

3.5 CLEANING AND PROTECTION

A. Clean products in accordance with the manufacturers recommendations.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Time switches.
2. Occupancy sensors.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
2. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding of lighting control devices referenced by this Section.
3. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers and supports referenced by this Section.
4. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
5. Section 262726 "Wiring Devices" for wall-box dimmers and manual light switches.

C. References:

1. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.
2. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.
3. NFPA 70 - National Electrical Code.

1.2 DEFINITIONS

A. BCELTS: Branch circuit emergency lighting transfer switch.

B. DPDT: Double pole double throw.

C. DPST: Double pole single throw.

D. N.C.: Normally closed.

E. N.O.: Normally open.

F. PIR: Passive infrared.

G. SPDT: Single pole double throw.

H. SPST: Single pole single throw.

1.3 ACTION SUBMITTALS

A. Submittals: Procedures for submittals. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

    a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
    b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
    c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for submitted product.

C. Shop Drawings: Prepare and submit the following:

1. Show installation details for the following:
    a. Occupancy sensors.
    b. Vacancy sensors.
2. Interconnection diagrams showing field-installed wiring.
3. Diagrams for power, signal, and control wiring.

D. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Submittals: Submittals for information. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Manufacturer's published instructions.

1.5 CLOSEOUT SUBMITTALS

A. Contract Closeout: Submittals for project closeout. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Record actual locations of each contactor and indicate circuits controlled on project record documents.

C. Maintenance Data: Include instructions for replacing and maintaining coil and contacts.

1.6 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements:

1. Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Must comply with CCR Title 24.

B. General:

1. The Occupancy Sensor system shall sense the presence of human activity within the spaces indicated and fully control the “On” / “Off” function of the lighting loads automatically. Sensors shall turn “On” the load upon entrance into the room and shall not initiate “On” outside of entrance.
2. Acceptable technology is Passive Infrared (PIR), Ultrasonic and Microphonic. Dual Technology is required utilizing PIR and one of the other technologies.
3. Occupancy sensors shall be field convertible to operate in either the occupancy or vacancy mode.
4. Sensors shall automatically adjust time delays and sensitivity based on the activity level in the space.
5. All line voltage devices shall be approved third party testing agency listed under Energy Management Equipment, or Industrial Control Equipment. Listing under Appliance Control shall not be accepted.
6. All line voltage devices shall be UL Listed under Energy Management Equipment, or Industrial Control Equipment. UL Listing under Appliance Control shall not be accepted.
7. Product shall be manufactured in the USA and be warranted for 5 years.

2.2 TIME SWITCHES

A. UL WGZR - Electronic Time Switch:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Eaton.
    b. Intermatic, Inc.
    c. Leviton Manufacturing Co., Inc.
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

4. Standard Features:

    a. Contact Configuration: DPST.
    b. Contact Rating: 30 A inductive or resistive, 277 V(ac).
    c. Programs:

        1) Eight on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays.

d. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
e. Astronomic Time: A**ll** channels.
f. Automatic daylight savings time changeover.
g. Battery Backup: Not less than seven days' reserve, to maintain schedules and time clock.

2.3 BUSINESS OCCUPANCY AND VACANCY SENSORS

A. Wall-Switch Occupancy Sensor:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton.
   b. Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
   c. Lithonia Lighting; Acuity Brands Lighting, Inc.

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for one of the following UL product categories:

   a. Photoelectric Controls: UL CCN WJCT, including UL 773A.
   b. Energy Management Equipment: UL CCN PAZX, including UL 916 or UL 60730-1.
   c. Intrusion Detection Units: UL CCN ANSR, including UL 639.

4. Standard Features:

   a. Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in single gang switchbox.

      1) Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
      2) Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
      3) Switch Rating: Not less than 800 VA LED load at 120 V, 1200 VA LED load at 277 V, and 800 W incandescent.

   b. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft.
   c. Sensing Technology: Dual technology - PIR and ultrasonic.
   d. Switch Type: Single pole or three/four way as noted.
   e. Capable of controlling load in three-way application.
   f. Voltage: Match circuit voltage.
   g. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. Switch prevents lights from turning on when light level is higher than set point of sensor.
   h. Time Delay:

      1) Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
      2) Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.

i. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
j. Color: Selected by Architect.
k. Faceplate: Color matched to switch.

2.4 EMERGENCY LIGHTING CONTROLS

A. UL WPWR - Branch Circuit Emergency Lighting Transfer Switch (BCELTS):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Bodine; Signify North America; Signify Holding.
b. Chloride; Signify North America; Signify Holding.
c. HLI Solutions; brand of GE Current, a Daintree Company.

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Automatic Transfer Switches: UL CCN WPWR, including UL 1008.

4. Standard Features:

a. Automatically shunts lighting switch upon signal from the fire alarm system or life safety automatic transfer switch.
b. Rating: 120 and 277 V, not exceeding 20 A.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

C. Ensure that outlet boxes are installed at the proper location.

D. Ensure that ceiling openings are neatly cut and will be completely covered by devices.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

F. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 SELECTION OF CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 INSTALLATION OF LIGHTING CONTROL DEVICES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Communications Work: BICSI N1.
6. Life Safety and Means of Egress Work: NFPA 101.
7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
8. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
2. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's instructions.
3. Installation of Industrial Control Switches: Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.
4. Installation of Wiring:

    a. Conduit: Minimum conduit size is 1/2 inch.
    b. Wiring within Enclosures: Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's published instructions.
    c. Size conductors in accordance with lighting control device manufacturer's published instructions unless otherwise indicated.
    d. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, device, and outlet boxes; terminal cabinets; and equipment enclosures.

D. Interfaces with Other Work:

1. Coordinate locations of outlet boxes provided under Section 260534 to obtain mounting heights specified and indicated on drawings.
2. All wiring devices shall be installed at heights as required by the A.D.A.
3. Install wall switch 48 inches (1.2 m) above finished floor, measured to bottom of outlet box.
4. Identification: Provide labels for lighting control devices and associated electrical equipment.
    a. Identify field-installed conductors, interconnecting wiring, and components.
    b. Label each enclosure with engraved metal or laminated-plastic nameplate.
    c. Identify controlled circuits in lighting contactors.
    d. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
    e. Label time switches and contactors with a unique designation.

3.4 FIELD QUALITY CONTROL

A. Quality Control. As required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Tests and Inspections:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Final Acceptance, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to the Project site during other-than-normal occupancy hours for this purpose. Some of the Work may be required during hours of darkness.

1. Contract Closeout: Adjust installed work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.
2. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
3. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
4. Align high-bay occupancy sensors using manufacturer's laser aiming tool.
5. Adjust devices and wall plates to be flush and level.

3.6 CLEANING

A. Contract Closeout: Clean installed work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION 260923

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SECTION 260943 - NETWORK LIGHTING CONTROLS

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Digital-network lighting control system and associated components:

1. Power panels.
2. LED drivers.
3. Power interfaces.
4. Lighting control modules.
5. Digital dimming ballast and switching modules
6. Lighting management hubs.
7. Lighting management system software.
8. Control stations.
9. Low-voltage control interfaces.
10. Wireless sensors.
11. Accessories.

1.2 RELATED SECTIONS

A. Section 265100 - Interior Fixtures

1.3 DEFINITIONS

A. The term Architect refers to the Architect, Lighting Designer or Owner's Representative individually or collectively.

B. The term Contractor refers to the bidding party of this document.

1.4 GENERAL REQUIREMENTS

A. Lighting controls equipment supplier will provide an ITEMIZED Bill of Materials with each control system component listed as a line item. Lot pricing is not acceptable.

B. Provide all control devices as shown complete with all components, completely wired, controlled and securely attached to supports.

C. Where a catalog number and a narrative or pictorial descriptions are provided, the written description shall take precedence and prevail.

D. General Contractor shall provide electrical subcontractor with entire lighting specification (including illustrations and sketches and cut sheets); electrical subcontractor shall provide each specified manufacturer with complete information about the control devices they will supply.

E. Type of control devices shall be as indicated alphanumerically and as specified.

F. Control device details shown may be modified by the manufacturer provided all the following conditions have been met:

1. Device performance is equal or improved;
2. Structural, mechanical, electrical, safety, and maintenance characteristics are equal or improved;
3. Cost to the Owner is reduced or equal.
4. Modifications have been reviewed by the Architect and have been approved by the Architect in writing.

1.5 REFERENCE STANDARDS

A. 47 CFR 15 - Radio Frequency Devices; Code of Federal Regulations; current edition.

B. ANSI C82.11 - American National Standard for Lamp Ballasts - High Frequency Fluorescent Lamp Ballasts - Supplements; 2011.

C. ANSI/ESD S20.20 - Standard for the Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices); 2014.

D. ASTM D4674 - Standard Practice for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Office Environments; 2002a (Reapproved 2010).

E. IEC 60669-2-1 - Switches for Household and Similar Fixed Electrical Installations - Part 2-1: Particular Requirements - Electronic Switches; 2015.

F. IEC 60929 - AC and/or DC-Supplied Electronic Control Gear for Tubular Fluorescent Lamps - Performance Requirements; 2011.

G. IEC 61000-4-2 - Electromagnetic Compatibility (EMC) - Part 4-2: Testing and Measurement Techniques - Electrostatic Discharge Immunity Test; 2008.

H. IEC 61000-4-5 - Electromagnetic Compatibility (EMC) - Part 4-5: Testing and Measurement Techniques - Surge Immunity Test; 2014.

I. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (Cor 1, 2012).

J. ISO 9001 - Quality Management Systems-Requirements; 2008.

K. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.

L. NECA 130 - Standard for Installing and Maintaining Wiring Devices; National Electrical Contractors Association; 2010.

M. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts; National Electrical Manufacturers Association; 2011.

N. NEMA WD 1 - General Color Requirements for Wiring Devices; National Electrical Manufacturers Association; 1999 (R 2010).

O. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

P. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

Q. UL 508 - Industrial Control Equipment; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

R. UL 508A - Industrial Control Panels; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

S. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.

T. UL 1472 - Solid-State Dimming Controls; Current Edition, Including All Revisions.

U. UL 1598C - Light-Emitting Diode (LED) Retrofit Luminaire Conversion Kits; Current Edition, Including All Revisions.

V. UL 2043 - Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces; Current Edition, Including All Revisions.

W. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.6 SYSTEM DESCRIPTION

A. Lighting Control System shall include computer-based software that provides control, configuration, monitoring and reports. System shall include the following components.

1. Control Unit (wired/wireless): Shall be the central intelligence point for the area as well as streaming ACN (sACN), Artnet, DMX, 0-10V, and/or wireless field devices it is programmed to control. Shall collect information from field devices, process and execute lighting changes. Shall be accessible via direct interface and/or remote network interface.
2. Lighting Control System Software: Shall be Native, Interactive and Web-based graphical user interface (GUI) that at minimum displays floor plans & lighting layouts and enable drag & drop addressing of devices & zones
3. System Server: Shall use industry standard operating system.
4. Lighting Network:
    a. Lighting control unit shall have network communication with Building Management and Exhibit Control devices.
    b. Lighting control unit shall have network communication via a separate VLAN with lighting data distribution devices in order to reduce data collisions and latency.
5. Drivers/Ballasts: Shall be industry standard, non-proprietary devices that rely on technologies such as DMX, Forward and Reverse Phase Cut Control, 0-10V, etc. for communication and control.
6. Exhibit Lighting Data Protocols:
    a. System shall support UDP input/output communication.
    b. System shall support DMX-over Ethernet control output Streaming ACN (sACN) and/or Artnet.
    c. System shall support direct DMX output.
    d. 0-10V/DALI communication shall only be used when DMX and Phase Cut control is not available, and only acceptable when controlled via DMX.
    e. Wireless communication shall only be used when DMX is not available, and only acceptable when controlled via DMX.
7. System Field Devices (Input/output Modules): Shall enable control of DMX devices; shall enable control of 0-10V field devices in the absence of DMX field devices.
8. Wall Stations: Shall be low voltage and communicate via field bus or wireless medium that uses non-proprietary open protocol for communication.
9. Communication Wire: Shall enable system devices control of DMX, 0-10V, or DALI field devices in the absence of wireless medium.
10. Occupancy Sensors: Shall be low voltage and communicate via field bus or wireless medium that uses non-proprietary open protocol for communication.
11. Photo Sensors: Shall be low voltage and communicate via field bus or wireless medium that uses non-proprietary open protocol for communication.

12. Area Lighting Controllers (dim/switch a group of luminaires): Shall communicate via field bus or wireless medium that uses non-proprietary open protocol for communication.
13. Relay based Lighting control panels: Shall communicate via field bus that carries DMX control signals or wireless medium that uses non-proprietary open protocol for communication.
14. AC Phase Cut Dimming Module (Forward & Reverse): Shall communicate via field bus that carries DMX control signals or wireless medium that uses non-proprietary open protocol for communication.
15. Interface to Audio Visual equipment (e.g. LCD Touch Screen Panel).
16. Interface to BACnet.
17. Interface to Tridium Niagara.
18. Interface to customizable Energy dashboard.

1.7 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate the placement of sensors and wall controls with millwork, furniture, equipment, etc. installed under other sections or by others.
2. Coordinate the placement of wall controls with actual installed door swings.
3. Coordinate the placement of daylight sensors with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.
4. Coordinate the work to provide luminaires and lamps compatible with the lighting controls to be installed.
5. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Pre-Wire Meeting: Conduct on-site meeting with lighting control system manufacturer prior to commencing work as part of manufacturer's standard startup services. Manufacturer to review with installer:
1. Low voltage wiring requirements.
2. Separation of power and low voltage/data wiring.
3. Wire labeling.
4. Lighting management hub locations and installation.
5. Where Lighting Control Manufacturer Sensor Layout and Tuning service is specified in Part 2 under "DIGITAL-NETWORK LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS", sensor locations to be reviewed in accordance with layout provided by Lighting Control Manufacturer. Lighting Control Manufacturer may direct Contractor regarding sensor relocation should conditions require a deviation from locations indicated.
6. Control locations.
7. Computer jack locations.
8. Load circuit wiring.
9. Network wiring requirements.
10. Connections to other equipment
11. Installer responsibilities.
12. Power panel locations.

C. Sequencing:
1. Do not install sensors and wall controls until final surface finishes and painting are

complete.

1.8 SUBMITTALS FOR REVIEW

A. General: Provide submittals per 1.8 (B – J) below:

B. Bill of Materials: Complete list of all parts needed to fully install selected system components.

C. Product Data: For each type of product indicated.

D. Shop and Wiring Drawings: Submit shop drawings detailing control system, as supplied, including one-line diagrams, wire counts, coverage patterns, interconnection diagrams showing field-installed wiring and physical dimensions of each item.

E. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.

1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.

F. Software Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On portable memory storage device, compact disc, or DVD, complete with data files.
3. Printout of software application and graphic screens, or upon request, a live demonstration of Control, Configure and Analyze functionality or a video demonstrating above stated system capabilities.

G. Installation Instructions: Manufacturer’s installation instructions.

H. Additional information as required on a project specific basis.

I. Operation and Maintenance Data: Include detailed information on lighting control system operation, equipment programming and setup, replacement parts, emergency operation and recommended maintenance procedures and intervals.

J. Warranty: Submit sample of manufacturer's Warranty or Enhanced Warranty as specified in Part 1 under "WARRANTY". Submit documentation of final execution completed in Owner's name and registered with manufacturer.

K. Software: One copy of software provided under this section.

1.9 SUBMITTALS FOR INFORMATION

A. Submittals for information shall follow the procedures, and be submitted in quantities and format, as described in the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Submit manufacturer’s installation instructions. Indicate application conditions and limitations of use. If applicable, indicate limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.10 QUALITY ASSURANCE

A. Installer Qualifications: Installer shall be one who is experienced in performing the work of this

section, and who has specialized in installation of work similar to that required for this project.

B. Manufacturer Qualifications:

1. Company with not less than ten years of experience manufacturing lighting control systems of similar complexity to specified system.
2. Registered to ISO 9001, including in-house engineering for product design activities.
3. Qualified to supply specified products and to honor claims against product presented in accordance with warranty.

C. Contractor shall ensure that lighting system control devices and assemblies are fully compatible and can be integrated into a system that operates as described in the lighting control notes on drawings and as described within this specification. Any incompatibilities between devices, assemblies, and system controllers shall be resolved between the contractor and the system provider, as required to ensure proper system operation and maintainability.

D. Performance Requirements: provide all system components that have been manufactured, assembled, and installed to maintain performance criteria stated by manufacturer without defects, damage, or failure.

E. Performance Testing Requirements

1. Manufacturer shall 100% test all equipment prior to shipment. Sample testing is not acceptable.

F. Code Requirements

1. System Control Unit and System Field Devices shall be UL listed and certified.
2. All system components shall be FCC /IC compliant.
3. All system components shall be installed in compliance with National Electrical Codes and Canadian Electrical Code.
4. Building Codes: All units shall be installed in compliance with applicable, local building codes.

G. ISO Certification: System components shall be manufactured at ISO-9000 certified plants.

H. Coordination

1. Coordinate lighting control components to form an integrated interconnection of compatible components.
    a. Match components and interconnections for optimum performance of lighting control functions.
    b. Display graphics showing building areas controlled; include the status of lighting controls in each area.

I. Conform to requirements of NFPA 70.

J. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.11 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1. System Requirements - Lutron, Unless Otherwise Indicated:
    a. Ambient Temperature:
        1) Lighting Control System Components, Except Those Listed Below: Between 32 and 104 degrees F (0 and 40 degrees C).
        2) Lighting Management System Computer: Between 50 and 90 degrees F (10

and 35 degrees C).

3) Fluorescent Electronic Dimming Ballasts: Between 50 and 140 degrees F (10 and 60 degrees C).

b. Relative Humidity: Less than 90 percent, non-condensing.

B. System Field Devices (Input and Output Modules) shall meet the following Environmental Conditions:

a. Operating Temperature Range: -40 deg F (-40 deg C) to 131 deg F (+55 deg C).

b. Humidity: 0% to 100% RH condensing rated for damp locations.0% to 95% RH non-condensing rated for indoor locations.

1.12 DELIVERY, STORAGE & HANDLING

A. Ordering: Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.

B. Delivery: Deliver materials in manufacturer's original, unopened, undamaged packaging with intact identification labels.

C. Storage and Protection: Store materials away from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

1.13 WARRANTIES

A. Manufacturer's Standard Warranty, With Manufacturer Start-Up;

1. Manufacturer Lighting Control System Components, Except Lighting Management System Computer, Ballasts/Drivers and Ballast Modules:

a. First Two Years from date of Acceptance by Owner:

1) 100 percent replacement parts coverage, 100 percent manufacturer labor coverage to troubleshoot and diagnose a lighting issue.

2) First-available on-site or remote response time.

3) Remote diagnostics for applicable systems.

b. Telephone Technical Support: Available 24 hours per day, 7 days per week, excluding manufacturer holidays.

2. Lighting Management System Computer: One year 100 percent parts coverage, one year 100 percent manufacturer labor coverage from date of Acceptance by Owner.

3. Ballasts/Drivers and Ballast Modules: Five years 100 percent parts coverage, no manufacturer labor coverage from date of Acceptance by Owner.

B. Include as part of the base bid additional costs for manufacturer's Enhanced Warranty with manufacturer Start-up; Platinum Enhanced Warranty; Lutron LSC-E8P; coverage to include items listed under manufacturer's standard warranty with manufacturer start-up above, plus the following upgrades:

1. Manufacturer Lighting Control System Components, Except Lighting Management System Computer, Ballasts/Drivers and Ballast Modules:

a. First Two Years:

1) Upgrade from as-available Field Service response to 24-hour on-site or remote response time.

2) Plus annual scheduled Preventive Maintenance Visit.

b. Additional Coverage for Years 3-5: 50 percent replacement parts coverage, no manufacturer labor coverage.

c. Additional Coverage for Years 6-8: 25 percent replacement parts coverage, no manufacturer labor coverage.

C. On-going system expansion, service and support shall be available from multiple factory certified vendors. Recommended service agreements shall be submitted at the time of bid complete with manufacturers suggested inventory and pricing for system parts and technical support labor.

D. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship within specified warranty period.

E. Manufacturer's Warranty: All equipment shall be warranted free of defects in materials and workmanship.

1. Warranty Period: All system hardware components, excluding third party components, shall have full warranty (non-prorated) for a period of forty-eight (48) months and all software, excluding Open Source Software and third-party operating systems, perform substantially in accordance with published specifications for a period of twelve (12) months from the date of System Acceptance by Owner.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Lighting Controller and Touch Panel Control Interface: Electronic Theater Controls, Pharos, Athena by Lutron

B. Building Lighting Interface: Electronic Theater Controls, Crestron, Lutron

C. Sensors: Electronic Theater Controls, Crestron, Lutron, Daintree, ENCELIUM Sensors by OSRAM SYLVANIA, Leviton Mfg. Co., Hubbell Building Automation, Inc.,SensorSwitch, Inc., PLC Multipoint Inc., The Watt Stopper, Inc. Cooper Controls or equivalent.

D. Phase Cut Dimming Drivers/Modules: Electronic Theater Controls, Varilite, Lightronics

E. 0-10V Dimming/Fixed Output Ballasts/Driver or DALI Ballasts/Drivers: OSRAM, Tridonic, Universal Lighting Technologies, Philips Lighting, Ecosense, or equivalent.

F. DMX Distribution: Pathway Connectivity, Obsidian Control Systems, Electronic Theater Controls

2.2 SYSTEM PERFORMANCE REQUIREMENTS

A. Refer to Lighting Drawings sheet LT-003 Light Fixture Schedule for 3-Spec Lighting Fixture and Controls Specifications.

B. This specification is intended to describe conceptually all of the design, engineering, programming, hardware, software, ancillary devices and associated technical services required to provide a building-wide networked lighting control system. This system is specified to perform scheduled and automated lighting control sequences.

C. The lighting control "system" shall include a fully distributed WAN/LAN network of global controller/routers, Individually addressable System Field Devices that are not integral to luminaires, sensors, switches, relays and other ancillary devices required for a complete and operable system. The system WAN/LAN start-up shall be by the control system manufacturer or contractors certified by the manufacturer.

D. The basis of system design shall utilize non-proprietary DMX Ballasts/Drivers and field bus driven occupancy sensors, daylight sensors, etc.

E. UL 924 listed devices shall have the ability to control 120V/277V/347V/480V load.

F. System software interface shall have the ability to notify communication failures to system users via system& email messages.

G. On-going system expansion, service and support shall be available from multiple factory certified vendors. Recommended service agreements may be submitted at the time of bid complete with manufacturers suggested inventory and pricing for system parts and technical support labor.

H. Lighting Control Software: The system shall offer two separate levels of lighting control: (1) personal lighting control for the average building occupant to control and adjust basic lighting functions in their workspace, and (2) central lighting control for the facility lighting administrator to perform energy management, configuration maintenance, monitoring operations, and providing support to building occupants.

1. Native central control software shall be utilized for energy reporting status and complete programming without the need for any third-party hardware or software. Systems that require any third party linked software or graphics shall be unacceptable.
2. Software shall provide information on general system settings via mouse click on a floor plan. Clicking over a device on the graphical software interface shall show a description of the selected device/function attribute.

I. Central Lighting Control:

a. Shall provide an Interactive, Web-based graphical user interface (GUI) showing floor plans and lighting layouts that are native to the lighting control software. The only means required to program and operate the lighting control system shall be programmed and operated from a user interface that is based on a plan view graphical screen on the user's computer or the lighting control system's main computer. Shall include the navigational features listed below to allow for user's orientation within the controlled space, geographic heading and/or landmarks:

1) Interactive;
2) Vector based;
3) Zoom;
4) Rotate;
5) Pan;
6) Tilt.

b. Shall allow building operator to navigate through an entire facility both in two-dimensional and three-dimensional multi-floor view, allowing for fast and easy navigation.

c. Three-dimensional view shall exclude walls and other structural features to avoid shadowing and cluttering of the plan view.

d. Shall display multiple floors in single view resulting in easier system performance visualization for the entire site as well as individual zones or spaces.

e. Shall allow system performance visualization across a portfolio of buildings via a single interface.

f. All programming, assignments of lighting loads to control strategies, lighting status and lighting energy reporting shall be native to the software and executed from this GUI. Editing shall be available from this GUI in a drag and drop format or from drop down menus without the need for any third-party software. Systems that utilize or require third party linked graphics are unacceptable. The GUI shall continuously indicate the status of each connected device on the system and a warning indicator on the software if a device goes offline. Systems requiring spreadsheet editing for programming and that don't offer real time feedback are not acceptable.

g. Software settings and properties shall be selectable per individual device, room based, floor based or global building based.

h. Lighting Control Software interface shall provide current status and enable configuration of all system zones including selected individual luminaire availability, current light level, maximum light level, on/off status, occupancy status, and emergency mode (response to an emergency signal) status.

i. Shall have the ability to display various lighting system parameters such as Lighting status (ON/OFF); Lighting levels; device uptime; last boot; file last uploaded, time zone and daylight savings status; time settings; and IP settings.

J. Logs: Log features shall be native to the lighting control software and capable of reporting the following parameters and their time of occurrence:

1. System Status
2. Input/Output commands
3. Internal Triggers

K. Personal Lighting Control: The Personal Control Software interface shall provide current status and enable each user with the ability to dim and brighten lights, and turn them on and off by individual luminaire or zone. The Software shall offer user configurable light scenes, which may be programmed and then selected via the Software. Personal lighting control shall be available in open/private office environments.

L. Daylight Harvesting (Light Regulation Averaging) via open-loop and/or closed-loop based technology: In a photo sensor-equipped system, the Central Controller Unit shall rationalize changes to light levels when ambient (natural) light is available and shall maintain a steady light level when subjected to fluctuating ambient conditions by dimming ballasts and/or drivers. Areas equipped with fixed output ballasts and/or drivers shall energize when natural light falls below foot-candle levels specified. System shall utilize light level inputs from common and/or remote sensor locations to minimize the number of photo sensors required. The System shall operate with multiple users in harmony and not react adversely to manual override inputs.

M. Time Clock Scheduling: The system shall be programmable for scheduling lights on or off via the Lighting Control Software interface.

1. Programming: User friendly, Outlook style interface shall be available for programming schedules.
2. Override: Manual adjustments via wall stations or personal control software shall temporarily override off status imposed by time clock schedule.
3. Response to Power Failure: In the event of a power failure, the time clock shall execute schedules that would still be in progress had they begun during the power outage.
4. Flicker Warning: Prior to a scheduled lights-off event or expiry of a temporary override, the system shall provide two short light level drops as a warning to the affected occupants. Flicker warning time shall have the ability to be programmed via software between 1 and 5 minutes.
5. Option to automatically turn on or wait for an input: Using this option, a group of luminaires can be made to turn on automatically in response to a scheduled event or wait for a signal from a wall station to turn the same group of luminaires on (and stay on) for the reminder of the scheduled event.

N. Emergency Mode: There shall be a mode, when activated through the system, that will immediately adjust lights to full light output and retain that level until the mode is deactivated in the event of an emergency. This setting shall override all other inputs. The system shall interface with the building emergency monitoring system via a single convenient point and not require multiple connections.

O. Addressing: All ballasts and/or drivers shall be centrally addressable, on a per luminaire or multiple luminaire/zone basis, through the Central Control Software. To simplify ongoing maintenance, the system shall not require manual recording of addresses for the purpose of start-up or reconfiguration.

P. Programmable Task Tuning: Maximum light level programmability shall be available by individual luminaire.

Q. Unoccupied State: The system shall provide two states when occupancy status is vacant as per an occupancy sensor - lights turn off or lights adjust to configurable (dimmed) light level.

R. Occupied State: The system shall be capable of creating “comfort” or “support” zones to ensure that occupants are not isolated by turning off lights in adjacent areas, such as a hallway path to exit the premises for occupant comfort and safety.

S. Overlapping Zones: System shall be capable of creating “overlapping” zones to ensure continuous lighting and safety of the occupants as they move from one lighting zone to another (for example, hallways) while minimizing the energy use.

T. Participation in Intelligent Building Framework: The system shall have the ability to be a component of Intelligent Building framework. Central Control Units and System server communication shall be based on TCP/IP over Ethernet backbone.

U. LAN Operations: System shall be capable of operating independent of building’s existing network infrastructure if desired and shall not rely on tenant supplied PCs for operation. Network infrastructure shall only be utilized for Personal Control Software.

V. Firewall Security: Firewall technology shall be utilized to separate tenants from the lighting control network.

W. Lighting Maintenance:

1. 0-10V Dimming, Fixed Output Ballast/LED Driver and/or Phase Cut Controllable Ballast/Driver replacements shall not require re-programming of the system or re-addressing of the said components.

X. Re-configurability: The assignment of individual luminaire to zones shall be centrally configurable by Central Control Software such that physical rewiring will not be necessary when workspace reconfiguration or re-zoning is performed. Removal of covers, faceplates, ceiling tiles, etc. shall not be required.

Y. Sensor Control Parameters: Occupancy sensor time delays shall be configurable through software. Light level sensor parameters shall be configurable through software.

Z. Automatic Time Adjustment: System shall automatically adjust for leap year and daylight savings time and shall provide weekly routine and annual holiday scheduling.

AA. Contact closure input: System shall be capable of receiving a momentary and sustained contact closure input from third party sources to control lighting zones.

BB. The system shall have the ability to control (dim/switch) a group of luminaires with loads up to 20A.

CC. The system shall offer occupancy sensing or time schedule based plug load control capability.

DD. Astronomical Clock feature: Luminaires switch ON/OFF with the sunset and sunrise, depending on the geographic location (latitude & longitude) of the building.

EE. System shall auto-configure lighting controls for spaces that have been combined or divided temporarily by moving wall or similar systems.

FF. System shall have the capability to emulate the changing colors of the natural daylighting cycle.

GG. System shall automatically lock wall stations and/or disable sensors based on one of the following system inputs: contact closure, a time schedule or the status of a monitored space.

HH. BAS Interface: The light management system shall be capable of interfacing digitally with a building automation system via either BACnet/IP or Tridium Niagara AX interface. The lighting control system shall be capable of communicating the status of output devices (lighting loads) as well as input devices (dry contacts, switches, occupancy sensors, vacancy sensors, and

photocells) to the BAS. Building Automation System, utilize data from lighting control system input devices such as occupancy sensors to determine the status (occupied/unoccupied) of the mechanical control zones and perform climate adjustments accordingly.

II. The light management system shall be capable of interfacing with audio-visual system (e.g. LCD Touch Screen Panel) via TCP/IP interface. Through this interface users can command various lighting scenarios depending on the audio & visual requirements of the room or building.

JJ. Migration plan to control LED luminaire: System shall be capable of migrating from the control of 0-10V Ballasts to 0-10V LED Drivers and/or Phase Cut Dimmable Ballasts/Drivers utilizing the same Output Modules without the need to change control hardware.

KK. Minimized system down time: Wired communication bus shall be able to self-diagnose and display communication shorts or open loops resulting in minimum system down time.

LL. AC Phase Cut Dimming Circuit Integration: System shall have the ability to control Incandescent, Fluorescent or LED lighting load that are otherwise controlled by manual AC Phase Cut Dimmers.

MM. Step Dimming & A/B Ballast Switching: System shall have the ability to perform Step Dimming & A/B Ballast Switching.

NN. Multiple Protocol Support: System design shall ensure seamless communication among devices when hybrid control systems are implemented. Hybrid control system refers to devices that communicate over a field bus that carry 0-10V/DALI or DMX control signals and/or wireless medium that use non-proprietary open protocol for communication. Devices in the hybrid control system shall communicate with all the devices in the system regardless of their native protocol they are designed to work with.

2.3 WALL STATIONS

A. Description: The system shall connect with the wall stations via field bus or wireless medium that uses non-proprietary open protocol for communication. All wall stations shall at minimum meet the following general specifications.

B. General

1. Software configurable wall station that provides on/off switching and dimming control for up to three lighting zones/scenes per wall station or more with allowable multi-gang configurations. Status is indicated by an LED display to indicate function, scene or zone. Allows manual override of the time schedule.
2. Manual dimming and/or switching wall station that provides local on/off and dimming control over at least three lighting zones. Allows manual dimming of light levels and override of the time schedule.
3. Scenes/zones in the central control software shall be synchronized with the buttons on the wall station.
4. Addressing: All wall stations shall be individually addressable & reconfigurable via Central Control Software.
5. Shall provide local on/off or dimming control over lighting zones.
6. Shall utilize standard single-gang or multi-gang form factor.
7. LEDs: All wall stations shall feature LEDs to indicate light on and light off status, as required.
8. Style: All wall stations shall feature Decorator styling wall plates and may be ganged together as required.
9. Lighting scenes shall automatically reconfigure based on scene changes from personal control software.

C. Electrical:

1. Class 2 Low Voltage device

D. Performance:

1. The following User Interface options shall be available:

a. Three (3) scene switching with dimming – Custom labeling available upon request

b. Three (3) zone switching – Custom labeling available upon request

c. One (1) zone switching – allows configuration as a vacancy sensor

E. Mechanical:

1. Dimensions: Shall meet NEMA WD-6 spec.

2. Color: Shall meet NEMA WD1 color specifications

3. Mounts in standard size wall box (suitable for multi gang installation) or on mounting brackets for low voltage devices.

4. Suitable for use with Decorator style wall plates.

F. Reliability:

1. Maximum Operating Ambient Temperature: 60 deg C (140 deg F).

2. Humidity: 5% to 95% RH non-condensing rated for indoor locations.

3. Industrial wall stations shall be available for damp location applications.

G. Regulatory:

1. Safety: UL916 listed

2. Environmental protection: Rated for dry location; RoHS compliant

3. Radio Interference: FCC Part 15/ICES-003

4. Shall comply or exceed the following electromagnetic requirements:

a. EN 61000-4-2

b. EN 61000-4-4

c. EN 61000-4-5

2.4 SYSTEM FIELD DEVICES (INPUT/OUTPUT MODULES)

A. Description: Input Modules provide a common interface to low voltage occupancy sensors and photo sensors while Output modules provide a common interface to 0-10V Dimming, Fixed Output Ballasts and/or 0-10V Dimming LED Drivers. These modules automatically detect the type of devices they are connected to (i.e., photo sensor, occupancy sensor, 0-10V ballast or 0-10V Dimming LED drivers. The Central Control Unit (CU), through these modules, assigns addresses to the field devices during system start-up and establishes two-way communication. These individually addressable modules enable each lighting component to be independently controlled and configured to best meet the needs of the facility. These modules connect directly to the NEC/CEC Class 2 communication bus. Wireless Control: When wireless equivalent of System Field Devices are used, these modules shall use non-proprietary open protocol for communication. DALI Gear: DALI gear if used in system design shall connect directly to DALI communication bus.

B. General:

1. Addressing: System Field Devices shall be individually addressable via Central Control Software.

2. System shall automatically address individual nodes during system start-up thus eliminating the need to pre-address devices or record serial numbers during installation.

3. Memory: Retains all system settings in non-volatile memory.

C. Electrical: Shall connect to NEC/CEC Class 2 communication bus.

D. Output Module: Input voltage: Ballast/General purpose/Tungsten: 120V – 480VAC

E. Input Module: Shall supply up to 24VDC to sensors.

F. Performance:

1. Control Options
    a. ON/OFF Switching
    b. Continuous dimming

G. Mechanical: Suitable for fixture or junction box mounting in standard 1/2" knockout (7/8” dia.)

H. Reliability:

1. Operating Temperature Range: -40 deg F (-40 deg C) to +131 deg F (+55 deg C)
2. Humidity: 0% to 100% RH condensing rated for damp locations. 0% to 95% RH non-condensing rated for indoor locations.

I. Regulatory:

1. Safety:
    a. UL916 listed
    b. UL924 listed
    c. UL2043 listed

2. Radio Interference: FCC Part 15/ICES-003 - Shall comply or exceed the following electromagnetic requirements:
    a. EN 61000-4-2
    b. EN 61000-4-4
    c. EN 61000-4-5

J. AIR GAP OFF – Output Module

1. Definition: Air Gap Off shall refer to the physical disconnection of AC power to the ballast or driver when “OFF” is selected either automatically or manually, thus ensuring maximum energy savings by eliminating off-state phantom power losses as well as ensuring that no potentially lethal high voltage is present at the ballast or driver when the lights appear to be off (for life-safety reasons).
2. Provisions: Provide an air-gap off relay for each control zone in the system. Where each luminaire is to be controlled (dimmed and/or switched) independently, provide one relay per luminaire. Where multiple luminaires are to be controlled (dimmed and/or switched), provide one relay per control zone, sized to handle both the inrush current as well as the maximum connected load, at the specified voltage.
3. Alternatively, for luminaire mounted at ceiling heights of 10’ or less, contractor may supply a label on each luminaire that is visible from 5’ AFF that states “WARNING: Potentially lethal voltage/currents may be present when lights are turned OFF”. Provide a sample of label as part of submittal process. For luminaire mounted above 10’, this provision is not an option.

2.5 AREA LIGHTING CONTROLLER

A. Description: Provides a common interface (DIM/SWITCH) a group of fixtures.

1. Communication: Shall communicate via NEC/CEC Class 2 field bus that carry 0-10V/DALI control signals or DMX or wireless media that uses non-proprietary open protocol for communication. DMX is preferred.

2. Addressing: Area Lighting Controllers shall be individually addressable via Central Control Software.
3. System shall automatically address individual area lighting controllers during system start-up thus eliminating the need to pre-address devices or record serial numbers during installation.
4. Area Lighting Controllers shall at minimum meet the general, mechanical and environmental specifications listed in 2.5 (B – F) below:

B. General:

1. Memory: Shall retain all system settings in non-volatile memory.
2. The internal relay shall control up to 20A for 120 to 347VAC general purpose loads, ballast, resistive, tungsten and motor loads of 1.5 HP for 120 to 277 VAC.
3. Shall be suitable for general purpose plug load control.
4. Dimming interface installation shall be either as NEC/CEC Class 1 or Class 2 circuit

C. Electrical:

1. Input voltage: Ballast/General purpose/Tungsten: 120V – 347VAC (+/-10%). 120-277 VAC Motor
2. Communication ports: Communication via NEC/CEC Class 2 communication bus.

D. Performance:

1. Control Options
   a. ON/OFF Switching
   b. Continuous dimming
   c. Shall be able to communicate with DMX or 0-10V ballasts/drivers as matches the control system.

E. Mechanical:

1. Mounting: Standard 1/2" electrical box knockout
2. Material: Plenum rated black plastic (UL2043)

F. Reliability:

1. Operating temperature range: 32°F (0°C) to 131°F (55°C)
2. Humidity: 5% to 95% RH non-condensing rated for indoor locations.

G. Regulatory:

1. Safety: UL916, UL924 & UL2043 listed
2. Environmental protection: Rated for damp location (IP54); RoHS compliant
3. Radio Interference: FCC Part 15/ICES-003
4. Shall comply or exceed the following electromagnetic requirements:
   a. EN 61000-4-2
   b. EN 61000-4-4
   c. EN 61000-4-5

2.6 WIRELESS DEVICES

A. Description: Wireless devices (Luminaires, Sensors & Wall Switches) Option #1: Wireless interface device shall provide a common interface to wireless sensors & wall switches. The Control Unit, through this interface module, automatically detects and during system start-up addresses the compatible wireless sensors & switches it is connected to and establishes two-way communication.

B. Option #2: Wireless interface device may replace the Control Unit and enable wireless control of luminaires, area lighting controllers, sensors and wall stations. The wireless interface device automatically detects and during system start-up addresses the compatible sensors, wall stations & wireless system field devices it is connected to and establishes two-way communication.

2.7 DMX DEVICES

A. Description: DMX gear shall be used in several areas. The Control System or Sub Systems shall communicate with the DMX gear directly or via DMX Interface device.

B. Addressing System: The Control System will be able to communicate and control each DMX device individually within all DMX standards across addresses 1 to 512 of every Universe and within as many Universes as needed for the installation.

2.8 COMMUNICATION WIRE

A. Description: The system shall have the capability to use both NEC/CEC Class 1 and Class 2 wiring.

B. General: Integrates peripheral devices such as ballasts/LED drivers, occupancy sensors, photo sensors, relay-based controls, power packs, wall controls and wireless sensors and wall controls into a complete, networked programmable lighting control system. Provides power to photo sensors, PIR and dual-technology occupancy sensors. Devices may be connected randomly on the network and special termination of each network channel is not required. Minimize system down time by self-diagnosing the field bus for any shorts and open loops.

C. Electrical: Power Supply: up to 24 VDC to sensors.

D. Mechanical:

1. Multi-conductor cable with stranded-copper conductors

E. Regulatory:

1. Flame rated jacket for plenum use NFPA 262 (UL: FT6, CSA: CMP).

2.9 RELAY BASED LIGHTING CONTROL PANELS

A. Description: An addressable lighting control panel that allows each relay to be individually controlled and configured.

B. General:

1. Addressing: All lighting control panel relays shall be individually addressable via Central Control Software.
2. Communication: All lighting control panels Shall communicate via a field bus that carry 0-10V/DALI control signals or wireless medium that uses non-proprietary open protocol for communication.
3. Wiring: Lighting control panels shall be interconnected on the same field bus as all other system components.
4. Relay Panel Modules are suitable for 35 mm DIN rail mounting.

C. Electrical:

1. Input Power Supply: 40 VA, 50/60 Hz
2. Shall have 2 ports that accept 18 AWG, pre-fabricated, polarity independent quick connecting Class 2 communication bus that supplies 24 VDC.

D. Performance: ON/OFF Switching

E. Reliability:

1. Maximum Operating Ambient Temperature: 60 deg C (140 deg F).

F. Regulatory:

1. Safety: UL916, UL924 listed
2. Radio Interference: FCC Part 15/ICES-003
3. Shall comply or exceed the following electromagnetic requirements:
    a. EN 61000-4-2
    b. EN 61000-4-4
    c. EN 61000-4-5

2.10 AC PHASE CUT DIMMING MODULE

A. Description: AC Phase Cut Dimming Modules provide a common interface to a group of Incandescent, Fluorescent or LED light systems that are otherwise connected to manual forward/reverse phase cut dimming devices. The Central Control Unit (CU), during start-up assign addresses to these controllers and establishes two-way communication. AC Phase Cut Dimming Modules shall at minimum meet the general, mechanical and environmental specifications listed (B – G) below:

B. General:

1. Addressing: AC Phase Cut Dimming Modules shall be individually addressable via Central Control Software.
2. Communication: All AC Phase Cut Dimming Modules shall communicate via a field bus that carry 0-10V/DALI control signals or DMX or wireless medium that uses non-proprietary open protocol for communication.
3. System shall automatically address individual AC Phase Cut Dimming Modules during system start-up thus eliminating the need to pre-address devices or record serial numbers during installation.
4. Memory: Shall retain all system settings in non-volatile memory.
5. Shall have built-in short circuit protection

C. Electrical:

1. Input Voltage: 120-277 VAC 50/60Hz
2. Communication ports: Communication via NEC/CEC Class 2 communication bus.

D. Performance:

1. ON/OFF Switching
2. Dimming

E. Mechanical:

1. Mounting on a standard square 4 and 11/16" junction box

F. Reliability:

1. Operating Temperature: 32 deg F (0 deg C) – 104 deg F (40 deg C)
2. Case Temperature: up to 158 deg F (70 deg C)

G. Regulatory:

1. Safety: UL916, UL924 listed
2. Radio Interference: FCC 47 CFR Part 18
3. Transient protection: ANSI C62.41 Category A

4. Shall comply or exceed the following electromagnetic requirements:
    a. EN 61000-4-2

2.11 PHOTO SENSOR

A. Description: The system shall utilize low voltage (wired/wireless) and/or DALI compliant photo sensors.

B. General:

1. Shall communicate via field bus that carries 0-10V/DALI control signals or DMX or wireless medium that uses non-proprietary open protocol for communication.
2. Sensor shall be capable of a fully adjustable response in the range between 0 and 10,000 foot candles with a +/- 1% accuracy at 70 deg F (21 deg C).
3. Shall interface directly with the analog input of the Lighting Control System.
4. Sensors shall supply an analog signal to the Lighting Management System proportional to the light measured.
5. Sensor housing shall be flame retardant and meet UL 94 HB standards.

C. Electrical:

1. NEC/CEC Class 2 based photo sensor shall have the following output voltage characteristics:
    a. Output Voltage: 5VDC or 10VDC full output
    b. Output Offset: 0VDC or 1VDC total Darkness

D. Reliability:

1. Accuracy: +/-1% at 70 deg F (21 deg C), derated to +/-5% at 120 deg F (49 deg C) or at 0 deg F (-18 deg C).
2. Operating Temp: 13 deg F (-11 deg C) to 140 deg F (60 deg C).
3. Interior: Indoor sensors shall have a Fresnel lens, with a 60 degree cone of response. The indoor sensor range shall be between 0 and 750 FC.
4. Exterior: Outdoor models shall have a hood over the aperture to shield the sensor from direct sunlight. The outdoor sensor circuitry shall be completely encased in an optically clear epoxy resin. The Outdoor sensor range shall be between 0 and 750 FC.
5. Atrium: The Atrium sensors shall have a translucent dome with a 180 degree field of view. Atrium sensor range shall be from 2 to 2,500 FC.
6. Skylight: The Skylight sensors shall have a translucent dome with a 180 degree field of view. Skylight sensor range shall be between 10 and 7,500 FC.

2.12 OCCUPANCY SENSORS

A. Description: The system shall utilize low voltage (wired/wireless) and/or DALI compliant occupancy sensors. Low voltage occupancy sensors shall at minimum meet the specifications listed below:

B. General:

1. Shall interface directly with the analog input of the Lighting Control System.
2. Shall communicate via field bus that carries 0-10V/DALI control signals or DMX or wireless medium that uses non-proprietary open protocol for communication.
3. Occupancy sensors shall employ passive infrared or ultrasonic or microphonic, and/or multi-technologies.

4. Shall allow timeouts configurable via system software.
5. Shall allow occupancy and vacancy sensor configurations via system software.
6. Depending on the software configuration shall switch or dim the luminaires.
7. Shall allow overlapping and comfort zone configurations via system software.

C. Mechanical: Sensors for mounting on ceilings and walls, including corners, must be available.

D. Reliability:

1. Operating Temperature Range: 32 deg F (0 deg C) to 104 deg F (40 deg DF)
2. Relative Humidity: 0% to 95% non-condensing

2.13 CONTROL UNIT

A. Description: The system Control Unit (CU) shall collect, process and distribute lighting control information to System Field Devices and Wall Stations over NEC/CEC Class 2 communication bus. Each CU has multiple NEC/CEC Class 2 communication channels and can control a large quantity of nodes (wired/wireless sensors, wired/wireless wall stations, Ballasts/Drivers, etc.) per channel, per the manufacturers recommended maximum. The CU is the central intelligence point for the area that it controls, collecting signal information from sensors, wall stations and personal control software and determining appropriate brightness levels or on/off status for each luminaire or zone. To enable personal control, each CU shall connect with facility's or tenant's local area network via TCP/IP based Ethernet connection.

B. See WIRELESS DEVICES for Wireless Control Unit description.

C. See DMX DEVICES for controlling DMX gear.

1. Shall interconnect with other CUs and System Server using standard Ethernet connection that employs TCP/IP protocol.
2. Control units shall at minimum meet the mechanical, electrical, data, electromagnetic and environmental specifications listed below.
3. Shall comply at minimum with FCC Part 15/ICES-003
4. Shall comply or exceed the following electromagnetic requirements:
    a. EN 61000-4-2
    b. EN 61000-4-4
    c. EN 61000-4-5

D. Mechanical Specifications:

1. Shall mount in a standard 19" rack (1U width), or alternatively where no rack is shown, via an individual wall mount.

E. Electrical Specifications:

1. Power Supply: 120VAC or 24VDC.

F. Data Specifications:

1. Shall have ports that enable communication via NEC/CEC Class 2 bus.
2. Each CU channel shall support up to 100 nodes or 800 nodes in total.
3. Each CU shall have Cat 5 RJ45 ports that employ TCP/IP protocol:
    a. Lighting Control Network
    b. Tenant LAN Access Point
4. Shall have a status LED on front of unit.
5. Shall have configuration stored in non-volatile flash memory.

G. Environmental Specifications:

1. Operating Temperature Range: -4 deg F (-20 deg C) to 104 deg F (+40 deg C).
2. Humidity: 0% to 95% RH non-condensing.

2.14 SYSTEM SERVER

A. Description: System Server shall host the lighting control system database for all the lighting control devices. In addition, it shall provide remote accessing capability to change system settings and/or parameters.

B. General:

1. Shall analyze system performance or energy data or generate system reports;
2. Shall record energy consumption with average sampling every 5 minutes for unlimited duration;
3. Shall host the web interface required for the web enabled Personal Control Software or web based Central Control Software;
4. Shall host industry standard operating system;
5. Shall reside on a client server (virtual server) thus eliminating the need for dedicated physical hardware;
6. Shall interconnect with wired/wireless CUs over standard Ethernet connection that employs TCP/IP protocol;
7. Hardware based servers shall at minimum meet the specifications listed in (C – E) below:

C. Electrical:

1. Power Supply: 120V/60Hz/200W. Provide dedicated 120V receptacle fed from a dedicated normal power circuit.
2. Communication ports: Minimum two (2) Ethernet 10/100Base - Tx Cat 5 RJ45 ports that employ TCP/IP protocol.

D. Mechanical:

1. Server hardware shall mount in a standard 19” rack (1U width), or alternatively where no rack is shown, via an individual wall mount.

E. Regulatory:

1. FCC (US only) Class A/DOC (Canada) Class A.
2. UL 60950.
3. CAN/CSA-C22.2 No. 60950.

2.15 LIGHTING CONTROL SYSTEM SOFTWARE

A. Personal Control Software: Enables individuals in a building to control lighting levels in their workspace from their own desktop PC. User can control the light level of each luminaire in their workspace or can control all of the luminaire together as a group. Preset lighting scenes may be stored, recalled and modified. This software shall have the capability of acting as a “virtual occupancy sensor” for the system by detecting keyboard or mouse activity on each PC for incremental occupancy status data.

1. Technical Information:

    a. TCP/IP network traffic < 2kb/s

B. Web based Personal Control Software: This feature allows individuals to control lighting levels in their workspace without the requirement for installation of software on client PCs. Individuals can

access the interface through the web browser and perform individual luminaire dimming control, on/off switching, modify and save preset lighting scenes.

C. System Requirements:

1. Internet web browser
2. Internet/Intranet connection
3. System server enabled and configured to host dynamic website
4. Network connection with access to a network-enabled CU

D. Web based Central Control Software: Central control software application is used to start-up, configure and manage the system. Every system parameter in a building (or campus of buildings) is configured for each individual user or space and baseline settings are established for each of the following (depending on the basis of design) system features:

1. Daylight harvesting
2. Occupancy control
3. Smart time scheduling
4. Task tuning
5. Personal control
6. Load shedding
7. Plug load control

E. Software utilizes a web-based interface that permits a user to easily navigate between zones, floors or different buildings and allows a user to zoom in or zoom out of specific areas of a building. Both 3-dimensional and two-dimensional multi-floor views shall be available. System features such as creation of zone hierarchies, overlapping and support zone definitions, user access rights, timeout settings for occupancy sensors, calibration of light levels for daylight harvesting and the configuration of multiple time schedule profiles shall be available. A web based Graphical User Interface (GUI) application integral to the system will be used to develop a dynamic, real-time, point-and-click graphic of each floor plan with representation of all light luminaire, wall stations, sensors, switches, etc. A central system server will be provided to support system data base and enterprise control management.

1. System Requirements:

a. Software must be able to run on a Windows Operating systems (Windows XP or newer) and also on Apple Mac Intel PCs (Mac OS 10.4 or newer).

b. Must support all common browsers, i.e.,
- Internet Explorer 6.0 or later
- Mozilla Firefox 3.0 or later
- Safari
- Google Chrome

c. Must provide network connection/access to all network-enabled CUs.

d. Color gradient (“weather map” type) data view (see below for an example) must be available to display the following criteria:
- Current luminaire brightness
- Current luminaire status
- Other custom modes that may be specified elsewhere

2.16 AUDIO-VISUAL INTERFACE

A. General: Through this interface users can command (e.g. LCD Touch Screen Panel) various lighting scenarios depending on the audio & visual requirements of the room or building.

1. The lighting control system shall interface to the AV system via TCP/IP protocol using Telnet.
2. The lighting control system shall allow a common AV processor to individually control multiple rooms from a single TCP/IP port through unique room, zone, and scene addresses for lighting in each room.

2.17 BAS INTERFACE

A. General: Two separate software interfaces (BACnet/IP or Tridium Niagara AX) shall be available for integration with Building Automation System. The lighting control system, via these interfaces, communicate the status of output devices (lighting loads) as well as input devices (dry contacts, switches, occupancy sensors, vacancy sensors, and photocells) over to the building automation system. Building Automation System, utilize data from lighting control system to switch/dim lighting, perform load shedding of lighting load, to turn lights on in response to emergency signal through fire alarm and perform HVAC adjustments.

1. The Lighting Control System shall be able to share the following information with BAS clients:
    a. Light Zone State: State of the defined lighting zone – ON or OFF
    b. Light Zone Dimming: Light output level of the defined lighting zone, from 100% (maximum light output) to 0% (minimum light output)
    c. Fire Alarm State: State of the fire alarm system – alarm activated or alarm not activated
    d. Occupancy State: State of the defined occupancy sensor – occupancy detected or not detected
    e. Photo Sensor Daylight Readings (available via BACnet interface only): Reports daylight readings by photo sensors
    f. Sheddable Load: Reports the total lighting load available for load reduction according to the Light Management System, defined in watts
    g. Shed Status: Reports the total current load reduction achieved according to Light Management System defined prioritization, defined in watts
    h. Shed Request: Requested total amount of load reduction, defined in watts or as a percentage of sheddable load
    i. Sheddable Load (Group): (As above, for the selected group)
    j. Shed Status (Group): (As above, for the selected group)
    k. Shed Request (Group): (As above, for the selected group)
    l. Floor plans (available via Tridium Niagara AX only): Importing lighting control software floor plans into Tridium Niagara AX framework for viewing current status and changing the proxy values.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Verification: Verify that wiring conditions, which have been previously installed under other sections or at a previous time, are acceptable for product installation in accordance with manufacturer's instructions.

B. Inspection: Inspect all material included in this contract prior to installation. Manufacturer shall be notified of unacceptable material prior to installation.

3.2 INSTALLATION

A. The Electrical Contractor, as part of the work of this section, shall coordinate, receive, mount, connect, and place into operation all equipment. The Electrical Contractor shall furnish all conduit, wire, connectors, hardware, and other incidental items necessary for properly functioning lighting control as described herein and shown on the plans (including but not limited to System Field Devices, 0-10V dimming ballasts, fixed output ballasts, 0-10V LED drivers and communication wire, DMX communication wire). The Electrical Contractor shall maintain performance criteria stated by manufacturer without defects, damage, or failure.

B. Power: The contractor shall test that all branch load circuits are operational before connecting loads to sensor system load terminals, and then de-energize all circuits before installation.

C. Related Product Installation: Refer to other sections listed in Related Sections for related products' installation.

3.3 SENSOR INSTALLATION

A. Adjust sensitivity to cover area installed.

B. Set time delay on occupancy sensors that are connect to the lighting control system to the minimum. Time delays shall be controlled via Central Control Software.

C. Install occupancy sensors on vibration free stable surface.

D. Install atrium and skylight light sensor facing toward window or skylight.

E. Install interior light sensor in ceiling facing the floor.

3.4 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 3/4 inch.

B. Wiring within Enclosures: Comply with NEC & CEC. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 SOFTWARE INSTALLATION

A. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current site licenses for software.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following field tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing wall stations and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and

equipment.

C. Lighting control devices will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.7 SYSTEM START-UP REQUIREMENTS & SUPPORT SERVICES

A. System Start-up: The manufacturer shall supply factory trained representatives to start-up the lighting control system.

B. Training: As part of the system start-up service, the provider of the service shall train the facility staff, or end users, responsible for changing the lighting characteristics in a building in the operation of the system. The start-up service provider shall also provide owner's representatives with system operating manuals.

C. Extended Service Coverage: Maintenance agreements shall be available from the manufacturer to provide service for the system both during and after the warranty period.

D. Electrical contractor shall perform functional testing under the guidance of technical service agent and in accordance with factory specified guidelines.

E. Technical service provider shall provide technical services for the lighting control system.

1. Verify proper communication over control wires.
2. Map addresses of all 0-10V, DMX gear and wireless devices.
3. Verify communication to control units and system server.
4. Software configuration of occupancy sensors, light level sensors, wall stations and other contacts to suit design specifications.
5. Configure and program lighting control sequences as described on contract documents.
6. Demonstrate to Owner and Engineer proper operation of all areas the system is installed.

3.8 TESTING & PROGRAMMING

A. Upon completion of all line, load and interconnection wiring, and after all luminaire are installed and lamped, a qualified factory representative shall completely configure and test the system.

B. The Lighting Control System is to be programmed by a qualified operator under the guidance of the Owner and the Lighting Design Team.

C. This includes setting up a schedule that includes preliminary programming prior to building occupancy based on initial discussions, and additional programming sessions based on feedback from the Owners, Architects and Lighting Designers.

D. Minimum requirements for the Lighting Control System Programmer(s) include:

1. Attending meetings during Bidding to discuss Scope of Work and confirm that the design requirements are possible with the proposed system.
2. Attending meetings after successful award of project during Construction Administration to reconfirm that the design requirements can be met.
3. Inclusion in the design of any software graphic layout.
4. Supervising system test to confirm all Control Systems and Sensors are working, and that all lighting fixtures test correctly.
5. Initial programming completed prior to move in and complete upon building handover. This will be based upon a definition provided by the Owners, Architects and Lighting Designers.
6. Programming revisions at the following time periods:

a. One week after building handover.
b. One month after building handover
c. Six months after building handover.
d. One year after building handover.

E. At the time of checkout and testing, the owner's representative shall be thoroughly instructed in the proper operation of the system.

3.9 DEMONSTRATION

A. The provider of the service shall train the facility staff, or end users, responsible for changing the lighting characteristics in a building to adjust, operate, utilize, troubleshoot, conduct software installation, and maintain lighting controls and software training for PC-based control systems.

END OF SECTION 260943

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SECTION 262213 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Distribution, dry-type transformers with nominal primary and secondary rating of 600 V and less, with capacities up to 150 kVA.
   a. Two-winding transformers.
   b. Two-winding transformers rated for nonlinear loads.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
2. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding products installed under this Section.
3. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers and supports referenced by this Section.
4. Section 260533.13 “Conduits for Electrical Systems”
5. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.

C. References:

1. NEMA ST 1 - Specialty Transformers (Except General-Purpose Type).
2. NEMA ST 20 - Dry-Type Transformers for General Applications.
3. NFPA 70 - National Electrical Code.
4. IEEE C57.96 (Standard transformers) and C57.110 (K Rated transformers) - Transformer Overload Capability.

1.2 ACTION SUBMITTALS

A. Submittals: Procedures for submittals. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data:

1. For each type of product.
   a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
   b. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

C. Shop Drawings:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
3. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Contract Closeout: Submittals for project closeout. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Manufacturers' Published Instructions: Record copy of official installation instructions issued to Installer by manufacturer for the following:

1. Transformer temporary heating, working clearances, anchoring, torque values, and insulation-resistance testing.

1.4 SUBMITTALS FOR CLOSEOUT

A. Contract Closeout: Submittals for project closeout. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Record actual locations of transformers in project record documents.

1.5 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Material and Equipment: Transport, handle, store, and protect products as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Inspection: On receipt, inspect for and note shipping damage to packaging and transformer.

1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.

C. Storage: Store in warm, dry, and temperature-stable location in original shipping packaging.

D. Temporary Heating: Apply temporary heat in accordance with manufacturer's published instructions within enclosure of ventilated-type units, throughout periods during which equipment is not energized and when transformer is not in space that is continuously under normal control of temperature and humidity.

E. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB, Electrification Business.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; Schneider Electric USA.
5. Substitutions: As permitted in relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Source Limitations: Obtain each type of transformer from single source from single manufacturer.

2.2 TWO-WINDING TRANSFORMERS

A. Description: NEMA ST 20, factory-assembled, air cooled dry type transformers, ratings as indicated. Transformers shall be energy efficient with minimum efficiencies as set forth in the Department of Energy 1/1/16 Standards.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

C. Primary Voltage: 480 delta volts, 3 phase.

D. Secondary Voltage: 208Y/120 volts, 3 phase.

E. Core Flux Density: Below saturation at 10 percent primary overvoltage.

F. Insulation and temperature rise: Class 220 insulation system with 115º C average winding temperature rise, as indicated on the Drawings.

G. Case temperature: Do not exceed 35º C rise above ambient at warmest point at full load.

H. Winding Taps:

1. Transformers Less than 15 kVA: Two 5 percent below rated voltage, full capacity taps on primary winding.
2. Transformers 15 kVA and Larger: NEMA ST 20.

I. Sound Levels: NEMA ST 20.

J. Basic Impulse Level: 10 kV for transformers less than 300 kVA, 30 kV for transformers 300 kVA and larger.

K. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

L. Mounting:

1. 1-15 kVA: Suitable for wall mounting. Provide manufacturers standard wall mounting brackets.
2. 16-75 kVA: Suitable for wall or floor mounting. If wall mounted, provide manufacturers standard wall mounting brackets.
3. Larger than 75 kVA: Suitable for floor mounting.

M. Coil Conductors: Continuous windings with terminations brazed or welded. Individually insulate secondary conductors and arrange to minimize hysteresis and eddy current losses.

N. Electrostatic Shield: Copper, between primary and secondary windings.

O. Enclosure: NEMA ST 20, Type 1 ventilated. Provide lifting eyes or brackets.

P. Isolate core and coil from enclosure using vibration-absorbing mounts.

Q. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.

2.3 TWO-WINDING TRANSFORMERS RATED FOR NONLINEAR LOADS

A. Description: NEMA ST 20, factory-assembled, air cooled dry type transformers, ratings as indicated, designed to supply nonlinear load (K-rated). Transformers shall be energy efficient with minimum efficiencies as set forth in the Department of Energy 1/1/16 Standards.

B. Primary Voltage: 480 delta volts, 3 phase.

C. Secondary Voltage: 208Y/120 volts, 3 phase.

D. Core Flux Density: Below saturation at 10 percent primary overvoltage.

E. Insulation and temperature rise: Class 220 insulation system with 115º C average winding temperature rise, as indicated on the Drawings.

F. Case temperature: Do not exceed 35º C rise above ambient at warmest point at full load.

G. Winding Taps:

1. Transformers Less than 15 kVA: Two 5 percent below rated voltage, full capacity taps on primary winding.
2. Transformers 15 kVA and Larger: NEMA ST 20.

H. Sound Levels: NEMA ST 20.

I. Basic Impulse Level: 10 kV for transformers less than 300 kVA, 30 kV for transformers 300 kVA and larger.

J. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

K. Mounting:

1. 1-15 kVA: Suitable for wall mounting. Provide manufacturers standard wall mounting brackets.
2. 16-75 kVA: Suitable for wall or floor mounting. If wall mounted, provide manufacturers standard wall mounting brackets.
3. Larger than 75 kVA: Suitable for floor mounting.

L. Coil Conductors: Continuous windings with terminations brazed or welded. Individually insulate secondary conductors and arrange to minimize hysteresis and eddy current losses at harmonic frequencies. Size secondary neutral conductor at twice the secondary phase conductor ampacity.

M. Electrostatic Shield: Copper, between primary and secondary windings.

N. Enclosure: NEMA ST 20, Type 1 ventilated. Provide lifting eyes or brackets.

O. Isolate core and coil from enclosure using vibration-absorbing mounts.

P. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.

2.4 SOURCE QUALITY CONTROL

A. Quality Control: Manufacturer quality control as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Production test each unit according to NEMA ST20.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for transformers.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's published instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be 5 Ω at location of transformer.

E. Environment: Enclosures must be rated for environment in which they are located. Covers for UL 50E, Type 4X enclosures may not cause accessibility problems.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounted transformers level and plumb with wall brackets fabricated.

1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
2. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by the manufacturer.
3. Brace wall-mounted transformers as specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

B. Install transformers level and plumb on concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

C. Construct concrete bases and anchor floor-mounted transformers in accordance with manufacturer's published instructions and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

2. Install floor-mounted transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure. Use one ½" thick, 4" square, resilient waffle design, oil-resistant elastomeric pad at each corner of the transformer, between the concrete base and the transformer frame, each sized for load of 50 pounds per square inch minimum.

D. Mount trapeze-mounted transformers as indicated utilizing minimum ½" galvanized all-thread rods and metal framing channels. Make double-nut connections between rids and channels. Locate transformers to provide adequate ventilation and accessibility.

E. Transformer Stacking Frame: Transformer stacking frames shall be constructed from 1⅝" x 1⅝" by 12 gage P1000 Unistrut channel, or approved equivalent, for the horizontal and vertical members. The maximum span for the horizontal members shall be 48 inches. The maximum height of vertical members shall be 60 inches. All connections shall be made with 1⅝" general fittings and post bases. Provide P2484W - 7 hole, 90° gusseted fittings at all horizontal to vertical connections. All connections shall follow requirements and recommendations of manufacturer.

F. For wall hung transformer installations, use spring type Korfund Series CE, sized for the transformer load. Provide sound pads at each corner of the transformer sized for ½" deflections. Securely anchor wall mounting brackets to wall to provide adequate support.

G. For floor and trapeze transformer installations, use one pad type Korfund Elasto-Grip waffle at each corner of the transformer, sized for load of 50 pounds per square inch.

H. Secure transformer to concrete base in accordance with manufacturer's published instructions.

I. Secure covers to enclosure and tighten bolts to manufacturer-recommended torques to reduce noise generation.

J. Remove shipping bolts, blocking, and wedges.

K. Transformers shall be installed in a manner to be fully compliant with the seismic restraint requirements of the North Carolina State Building Code. Provide mounting devices and hardware, bracing, fittings, etc. as required for seismic restraint.

3.3 CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Use flexible conduit, under the provisions of Section 260533.13 “Conduits for Electrical Systems”, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

D. Tighten electrical connectors and terminals in accordance with manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

E. Provide flexible connections at conduit and conductor terminations and supports to eliminate sound and vibration transmission to building structure.

3.4 FIELD QUALITY CONTROL

A. Quality Assurance: Field inspection, testing, adjusting shall be as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

3.5 ADJUSTING

A. Contract Closeout: Adjust installed work as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Measure primary and secondary voltages and make appropriate tap adjustments.

C. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

D. Output Settings Report: Prepare a written report recording output voltage and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262213

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SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Switchboards.
2. Surge protection devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.

B. Related Requirements:

1. Section 033000 “Cast-In-Place Concrete” specifies Equipment Bases and Foundations referenced by this Section.
2. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
3. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
4. Section 260529 "Hangers and Supports for Electrical Systems" specifies concrete bases and supports for panelboards installed by this Section.
5. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies seismic control devices, mounting devices, and anchoring devices installed by this Section.
6. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
7. Section 260573 "Power System Studies" for Short-circuit, Overcurrent protective device coordination, arc-flash hazard analysis and arc-flash label requirements.
8. Section 265650 “Electrical Systems Commissioning”
9. Section 262813 “Fuses” specifies fuses referenced by this Section.
10. Section 264313 “Surge Protective Devices for Low-Voltage Electrical Power Circuits” specifies surge protection referenced by this Section.

C. References:

1. ANSI C12 - Code for Electricity Metering.
2. ANSI C39.1 - Requirements for Electrical Analog Indicating Instruments.
3. ANSI C57.13 - Requirements for Instrument Transformers.
4. ANSI/UL 1283 Standard for Safety, Electromagnetic Interference Filters, 5th Ed.
5. ANSI/UL 1449 Standard for Safety, Surge Protective Devices, 5th Ed.
6. NEMA AB 1 - Molded Case Circuit Breakers.
7. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
8. NEMA PB 2 - Dead Front Distribution Switchboards.
9. NEMA PB 2.1 - Instructions for Safe Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.
10. NFPA 70 - National Electrical Code.
11. UL891 – Standard for Switchboards.

12. UL489 – Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures

1.2 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.3 ACTION SUBMITTALS

A. Submittals: Procedures for submittals. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data:

1. Switchboards.
2. Overcurrent protective devices.
3. Surge Protection devices Type (1 or 2).
    a. Modes of Protection (L-N, L-G, L-N, L-L).
    b. Voltage Protection Rating (VPR).
4. OCPD Requirements.
5. NEMA 250 Enclosure Type.
6. Ground-fault protection devices.
7. Accessories.
8. Other components.
9. Include dimensions, weight, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

C. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than UL 50E, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series rating of installed devices.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards.
9. Include diagram and details of proposed mimic bus.
10. Include schematic and wiring diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Submittals: Submittals for information. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.5 CLOSEOUT SUBMITTALS

A. Submittals for project closeout. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Record actual locations of switchboard in project record documents.

C. Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

D. Test Reports: Indicate results of factory production tests.

1.6 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum ten years documented experience.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Contract Closeout shall be as specified under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Furnish two of each key.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Transport, handle, store, and protect products under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

C. Deliver in 48-inch maximum width shipping splits, individually wrapped for protection and mounted on shipping skids.

D. Store in a clean, dry space. Provide space heaters to maintain a condensation free environment. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

E. Handle in accordance with NEMA PB 2.1 and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.9 FIELD MEASUREMENTS

Verify that field measurements are as indicated on shop drawings.

1.10 SOURCE QUALITY CONTROL

A. Manufacturer quality control shall be as specified under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Shop inspect and test switchboard according to NEMA PB 2.

PART 2 - PRODUCTS

2.1 SWITCHBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB, Electrification Business.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; Schneider Electric USA.
5. Substitutions: As permitted in relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Description: NEMA PB 2 switchboard with electrical ratings and configurations as indicated and specified.

C. Ratings:

1. Voltage: 277/480 volts.
2. Configuration: Three phase, four wire wye, grounded.
3. Main Bus: Rating as shown on the drawings.
4. Integrated Equipment Rating: Rating as shown on the drawings.

D. Front connected, front accessible.

E. Main Devices: Drawout mounting.

F. Feeder Devices: Drawout mounting for circuit breakers over 1,200A; individually mounted for smaller circuit breakers.

G. Auxiliary Section Devices: Individually mounted.

H. Bus Material: Copper with silver plating, standard size.

I. Bus Connections: Bolted, accessible from front only for maintenance.

J. Copper Ground Bus: Extend length of switchboard.

K. Solid-state Trip Molded (up to 1,200A) and Insulated Case Main Circuit Breakers (larger than 1,200A): NEMA AB 1 with full-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings

1. Adjustable instantaneous trip.
2. Adjustable long time pickup and delay.
3. Adjustable short time pickup and delay.
4. Ground fault pickup and delay.
5. Arc flash reduction mode with external switch and indicator (1,200A and larger).
6. Include shunt trip, undervoltage release, and other accessories where indicated.
7. Display line currents and cause of trip.

L. Solid-state Trip Molded (up to 1,200A) and Insulated Case Feeder/Branch Circuit Breakers (larger than 1,200A): NEMA AB 1 with full-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings

1. Adjustable instantaneous trip.
2. Adjustable long time pickup and delay.
3. Adjustable short time pickup and delay.
4. Ground fault pickup and delay.
5. Arc flash reduction mode with external switch and indicator (1,200A and larger).
6. Include shunt trip, undervoltage release, and other accessories where indicated.
7. Display line currents and cause of trip.

M. Electronic trip units shall be provided with external, permanently-mounted power supplies in the gear where required to program trip units while the breakers are deenergized.

N. Line and Load Terminations: Accessible from the front of the switchboard, suitable for the conductor materials and sizes indicated.

O. Key Interlock Kit: Where noted, externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.

P. Drawout Circuit-Breaker Compartment:
1. Drawout Features: Circuit-breaker mounting assembly equipped with racking mechanism to position circuit breaker and hold it rigidly in connected, test, disconnected, and withdrawn positions. Include the following features:
2. Provide circuit-breaker racking system with positive stops at connected, test, disconnected, and withdrawn positions.
3. Interlocks: Prevent racking of circuit breaker to or from connected position when it is closed, and prevent closure of circuit breaker unless it is in connected, test, or disconnected position.
4. Circuit-Breaker Positioning: Permit racking of open circuit breaker to or from connected, test, and disconnected positions only when compartment door is closed unless live parts are covered by full dead-front shield shutter. Permit manual withdrawal of open circuit breaker to position for removal from structure. When compartment door is open, status for connection devices for different positions includes the following:
   a. Test Position: Primary disconnects disengaged, and secondary disconnect devices and ground contact engaged.
   b. Disconnected Position: Primary and secondary devices and ground contact disengaged.
5. Primary Disconnect: Mount on stationary part of compartment. Disconnect must consist of set of contacts extending to rear through insulating support barrier, and of corresponding moving finger contacts on power circuit-breaker studs, which engage in only connected position. Assembly must provide multiple silver-to-silver full floating, spring-loaded, high-pressure-point contacts with uniform pressure on fingers. Load studs

must connect to bus extensions that terminate in solderless terminals in rear cable compartment.

6. Secondary Disconnect: Floating terminals mounted on stationary part of compartment that engage mating contacts at front of breaker.
7. Place 2,400A frame and larger circuit breakers at middle or top for bottom entry and at middle or bottom for top entry.

Q. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Provide continuous current rating as indicated.

R. Enclosures: Type 1 – General Purpose.

1. Align sections at front and rear.
2. Switchboard Maximum Height: 96 inches, excluding floor sills, lifting members and pull boxes.
3. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.
4. Mimic Bus: Show bussing, connections and devices in single line form on the front panels of the switchboard using blue color factory painting, or approved equivalent means.

2.2 CONTROL POWER

A. Control Circuits:

1. 120 VAC, supplied through secondary disconnecting devices from control-power transformer.

B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.3 METERING

A. Each switchboard shall be provided with a front mounted, digital power quality meter / analyzer package. The metering shall include a lighted LCD display of voltage, current, power, kVA, kVAR, power factor, frequency, total harmonic distortion, kW demand, amperes demand, kWH, kVARH, auxiliary voltage input and neutral current. Phase switching shall be provided and the display shall indicate the phase being displayed. The meter shall have an RS485 Modbus and ethernet ports for Owner interface. Provide all voltage and current transformers required to provide the above data.

B. Manufacturers: The metering/analyzer package shall be:

1. Eaton PXE Tier 1.
2. General Electric/ABB.
3. Siemens.
4. Square D/Schneider.

5. Substitutions: refer to provisions of the General and supplemental General Conditions and Division 1 specification sections.

C. Install at 60" AFF to bottom of the meter case or, if the meter is to be installed above 60" AFF but no more than 78"AFF, provide an angle adapter to lower the meter viewing angle. Angle adapter shall be acceptable to the Architect/Engineer.

2.4 METERING TRANSFORMERS

A. Current Transformers: ANSI C57.13, 5 ampere secondary, bar or window type, with single secondary winding and secondary shorting device, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

B. Potential Transformers: ANSI C57.13, 120 volt secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Mounting Accessories: For anchors, mounting channels, bolts, washers, and other mounting accessories, comply with requirements in Section 260548.16 "Seismic Controls for Electrical Systems" or manufacturer's instructions.

B. Provide drawout circuit breaker trolly/lift for all switchboards with drawout mounting circuit breakers.

C. Racking handle to move circuit breaker manually between connected and disconnected positions.

D. Provide with integral surge protection device with overcurrent protection. See Specifications Section 264313.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards in accordance with NEMA PB 2.1.

1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's published instructions.
2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
3. Protect from moisture, dust, dirt, and debris during storage and installation.
4. Install temporary heating during storage in accordance with manufacturer's published instructions.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect performance of equipment.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Provide 4 inch concrete housekeeping pad under the provision of Division 3.

3.3 INSTALLATION

A. Comply with manufacturer's published instructions, recommendations, applicable electrical codes and the contract drawings.

B. Reference Standards:

1. Switchboards and Accessories: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA PB 2.1.
2. SPD, comply with NECA 1.
3. Consult Architect for resolution of conflicting requirements.

C. Switchboards shall be installed in a manner to be fully compliant with the seismic restraint requirements of the North Carolina State Building Code. Provide mounting devices and hardware, bracing, fittings, etc. as required for seismic restraint. See Section 260010, Paragraph 1.24 for additional requirements.

D. Special Techniques:

1. Equipment Mounting: Install switchboards on concrete base, 4 inch nominal thickness. Comply with requirements for concrete base specified in Section 260529 "Hangers and Supports for Electrical Systems."

    a. Install conduits entering underneath switchboard, entering under vertical section where conductors will terminate. Install with couplings flush with concrete base. Extend 2 inch above concrete base after switchboard is anchored in place.
    b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18 inch centers around full perimeter of concrete base.
    c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
    d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, published instructions, and directions furnished with items to be embedded.
    e. Install anchor bolts to elevations required for proper attachment to switchboards.
    f. Anchor switchboard to building structure at top of switchboard if required or recommended by manufacturer.

2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.

3. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
4. Operating Instructions: Frame and mount printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
5. Install filler plates in unused spaces of panel-mounted sections.
6. Install overcurrent protective devices, surge protection devices, and instrumentation.
    a. Set field-adjustable switches and circuit-breaker trip ranges.
7. Install spare-fuse cabinet.

E. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.

F. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

G. Use crimped connectors and splices only. Wire nuts are unacceptable.

H. Upon completion of installation, and prior to final inspection, the Electrical Contractor shall reduce in size the “as-built” single line diagram (riser), frame same under plexiglass, and mount in a conspicuous place adjacent to the switchboard.

3.4 CONNECTIONS

A. Bond conduits entering underneath switchboard to equipment ground bus with bonding conductor sized in accordance with NFPA 70.

B. Support and secure conductors within switchboard in accordance with NFPA 70.

C. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.5 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Mimic Bus:

1. Entire single-line switchboard bus work, as depicted on factory record drawing, on minimum 0.032 inch thick anodized aluminum photoengraved nameplate, located at eye level on front cover of switchboard incoming service section.
2. Entire single-line switchboard bus work, as depicted on factory record drawing, on engraved minimum 0.0625 inch thick laminated-plastic nameplate, located at eye level on front cover of switchboard incoming service section.
3. Continuously integrated mimic bus factory applied to front of switchboard. Arrange in single-line diagram format, using symbols and letter designations consistent with final mimic-bus diagram.
4. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce concise visual presentation of principal switchboard components and connections.
5. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.

E. Service Equipment Label: Labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

3.6 FIELD QUALITY CONTROL

A. Field inspection, testing and adjusting shall be as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Standard factory tests shall be performed on the equipment under this section. All tests shall be in accordance with the latest version of UL, IEEE, and NEMA standards.

C. Perform the following field tests and inspections with the assistance of a factory-authorized service representative.

1. Compare equipment nameplate data for compliance with Drawings and Specifications.
2. Inspect anchorage, alignment, grounding, and clearances.
3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

D. Tests and Inspections:

1. Acceptance Testing:
   a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
   b. Test continuity of each circuit.
2. Test ground-fault protection of equipment for service equipment in accordance with NFPA 70.
3. Provide performance testing of arc energy reduction systems as required by NEC Art. 240.87(C).
4. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
5. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. Nonconforming Work:

1. Switchboard will be considered defective if it does not pass tests and inspections.
2. An SPD will be considered defective if it does not pass tests and inspections.
3. Remove and replace defective units and retest.

F. Collect, assemble, and submit test and inspection reports, including certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.7 STARTUP SERVICE

A. Complete startup checks according to manufacturer's written instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

3.8 ADJUSTING

A. Testing, Adjusting, and Balancing: Adjust installed work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

C. Tighten bolted bus connections in accordance with manufacturer’s instructions.

D. Adjust circuit breaker trip and time delay settings to values as required by the Coordination Study. Prior to final settings, adjust circuit breaker trip and time delay settings to minimum values that do not cause false tripping.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate and maintain SPDs.

3.10 CLEANING

A. Clean installed work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Cleaning: Vacuum dirt and debris from switchboard interior; do not use compressed air to assist in cleaning.

C. Touch up scratched or marred surfaces to match original finish.

3.11 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature in accordance with manufacturer's published instructions, until switchboard is ready to be energized and placed into service.

END OF SECTION 262413

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SECTION 262416 – PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Branch Circuit Panelboards.
2. Distribution Panelboards.
3. Disconnecting and overcurrent protective devices.

B. Related Requirements:
1. Section 260010 "Supplemental Requirements for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other requirements applicable to the Work for electrical, communications, and electronic safety and security systems on Project, including wiring methods.
2. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
3. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies seismic control devices, mounting devices, and anchoring devices installed by this Section.
4. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.
5. Section 260573 "Power System Studies" specifies short-circuit current studies, overcurrent protective device coordination studies, and arc-flash hazard analysis studies.
6. Section 265650 “Electrical Systems Commissioning.”
7. Section 262813 "Fuses" specifies fuses and spare-fuse cabinets installed by this Section.
8. Section 264313 "Surge Protective Devices for Low-Voltage Electrical Power Circuits" specifies Type 1 and Type 2 surge protective devices installed by this Section.

C. References:

1. NECA Standard of Installation (published by the National Electrical Contractors Association).
2. NEMA AB1 - Molded Case Circuit Breakers.
3. NEMA ICS 2 - Industrial Control Devices, Controllers and Assemblies.
4. NEMA KS1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
5. NEMA PB 1 - Panelboards.
6. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
7. NFPA 70 - National Electrical Code.

1.2 DEFINITIONS

A. MCCB: Molded-case circuit breaker.

B. VPR: Voltage protection rating.

1.3 ACTION SUBMITTALS

A. Submittals: Procedures for submittals. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: For each type of product. In addition to information identified in Section 013300 "Submittal Procedures," submit the following:

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.
2. Include manufacturer's sample extended warranty language.

C. Shop Drawings: For each panelboard and related equipment:

1. Include dimensioned plans, elevations, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series rating of installed devices.
7. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for SPD as installed in panelboard.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include circuit breaker and fusible switch arrangement and sizes.
10. Include wiring diagrams for power, signal, and control wiring.
11. Key interlock scheme drawing and sequence of operations.
12. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include Internet link for electronic access to downloadable PDF of coordination curves.
13. Arrange panelboard branch circuit breakers as shown on the Drawings. Agreement of circuit breaker (pole) numbers with the Drawings panel schedules and floor plans is required in order to avoid confusion during construction, redrawing the circuitry for record drawing purposes and accurate documentation of the as-built conditions.

D. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Submittals: Submittals for information. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Panelboard Schedules: For installation in panelboards.

C. Submit manufacturer’s installation instructions. Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

D. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Field reports for voltage monitoring and adjusting.

1.5 CLOSEOUT SUBMITTALS

A. Contract Closeout: Submittals for project closeout. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Record actual locations of panelboards and record actual circuiting arrangements in project record documents.

C. Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

D. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Contract Closeout. As required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Furnish two of each panelboard key.

1.7 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation in accordance with NEMA PB 1.

1.9 WARRANTY

A. Installer warrants that fabricated and installed panelboards perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within one year of Final Acceptance.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Fabricate and test panelboards in accordance with IEEE 344 to withstand seismic forces specified in Section 018123 "Facility Seismic and Wind Criteria."

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Comply with NEMA PB 1.

E. Enclosures: Flush and Surface-mounted, dead-front cabinets.
   1. Rated for environmental conditions at installed location. NEMA-4X surface mounted unless noted otherwise. NEMA-1 flush mounted in dry, conditioned, finished spaces.
   2. Height: 7 ft maximum.
   3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims must cover live parts and may have no exposed hardware.
   4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims must cover live parts and may have no exposed hardware.
   5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
   6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
   7. Finishes:
      a. NEMA-1 Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat. Back Boxes: Galvanized steel.
      b. NEMA-4X Panels and Trim: Stainless Steel. Back Boxes: Stainless steel.

F. Phase, Neutral, and Ground Buses:

   1. Material: Hard-drawn copper, 98 percent conductivity.

      a. Plating must run entire length of bus.
      b. Bus must be fully rated for entire length.

   2. Interiors must be factory assembled into unit. Replacing switching and protective devices may not disturb adjacent units or require removing main bus connectors.
   3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

G. Conductor Connectors: Suitable for use with conductor material and sizes.

   1. Material: Hard-drawn copper, 98 percent conductivity.
   2. Terminations must allow use of 75 deg C rated conductors without derating.
   3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
   4. Main and Neutral Lugs: Mechanical type, with lug on neutral bar for each pole in panelboard.
   5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with lug on bar for each pole in panelboard.

H. Quality-Control Label: Panelboards or load centers must be labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards

or load centers must have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

I. Future Devices: Panelboards or load centers must have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

1. Percentage of Future Space Capacity: As shown.

J. Panelboard Short-Circuit Current Rating:

1. Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for 100 percent interrupting capacity.

a. Panelboards and overcurrent protective devices rated 240 V or less must have short-circuit ratings as shown on Drawings, but not less than 10 000 A(rms) symmetrical.
b. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V must have short-circuit ratings as shown on Drawings, but not less than 14 000 A(rms) symmetrical.

2.2 PANELBOARDS

A. UL QEUY - Distribution Panelboard:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. ABB, Electrification Business.
b. Eaton.
c. Siemens Industry, Inc., Energy Management Division.
d. Square D; Schneider Electric USA.
e. Substitutions: As permitted in relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Distribution Type Panelboards: UL CCN QEUY; including UL 67 and NEMA PB 1.

4. Service Conditions:

a. Temperature: 104º F. (40º C.).
b. Altitude: N/A.
c. Terminal Rating: 75º C. minimum.

5. Standard Features:

a. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1) For doors more than 36 inch two latches, keyed alike.
b. Panelboard Bus: Copper, ratings as indicated. Provide 100% copper ground and neutrals buses in each panelboard. Provide insulated ground bus where

scheduled. Provide 200% copper neutral bus in each panelboard fed by a K rated transformer.

c. Minimum integrated short circuit rating: 10,000 amperes rms symmetrical for 208-volt panelboards; 30,000 amperes rms symmetrical for 480-volt panelboards, or as indicated.

d. Mains: Circuit breakers: NEMA AB 1, bolt-on or plug-on (Square D I-Line and similar only) type.

1) Circuit breakers in distribution panelboards shall be fully rated.

2) Solid-state Trip Molded Case Main and Branch Circuit Breakers (where required by Coordination Study): Panel mounted, NEMA AB 1, with electronic sensing, timing and tripping circuits for adjustable current settings. Electronic trip units shall be provided with external, permanently-mounted power supplies in the gear where required to program trip units while the breakers are deenergized. Trip units shall be field-programmable with an internal display for programming and display and have:

a) Adjustable instantaneous trip.

b) Adjustable long time pickup and delay.

c) Adjustable short time pickup and delay.

d) Ground fault pickup and delay.

e) Arc flash reduction mode with external switch and indicator (1,200A and larger).

f) Include shunt trip, undervoltage release, and other accessories where indicated.

g) Display line currents and cause of trip.

3) Conventional Thermal Magnetic Molded Case Branch Circuit Breakers: Circuit breakers with integral thermal and instantaneous magnetic trip in each pole.

4) Circuit Breaker Accessories: Trip units and auxiliary switches as indicated.

6. Enclosure: NEMA PB 1, Type 4X, cabinet box as specified.

7. Cabinet Front: Flush and Surface cabinet front door-in-door type with concealed trim clamps, concealed hinge, metal directory frame, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel. Distribution panelboards larger than 400 amperes are not required to have door-in-door trims.

8. Other Available Features Required by Project (see panelboard schedules):

a. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.

b. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure.

c. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors must be sized for double-sized or parallel conductors as indicated on Drawings.

d. Do not mount neutral bus in gutter.

e. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

B. UL QEUY – Branch Circuit Panelboard:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABB, Electrification Business.

b. Eaton.

c. Siemens Industry, Inc., Energy Management Division.

d. Square D; Schneider Electric USA.
e. Substitutions: As permitted in relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

2. Source Limitations: Obtain products from single manufacturer.

3. Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.

4. Service Conditions:
   a. Temperature: 104º F. (40º C.).
   b. Altitude: N/A.
   c. Terminal Rating: 75º C. minimum.

5. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Lighting and Appliance Branch-Circuit Type Panelboards: UL CCN QEUY; including UL 67 and NEMA PB 1.

6. Standard Features:

   a. Mains: Circuit breakers: NEMA AB 1, bolt-on type.
      1) Circuit breakers in distribution panelboards shall be fully rated.
      2) Solid-state Trip Molded Case Main and Branch Circuit Breakers (where required by Coordination Study): Panel mounted, NEMA AB 1, with electronic sensing, timing and tripping circuits for adjustable current settings. Electronic trip units shall be provided with external, permanently-mounted power supplies in the gear where required to program trip units while the breakers are deenergized. Trip units shall be field-programmable with an internal display for programming and display and have:
         a) Adjustable instantaneous trip.
         b) Adjustable long time pickup and delay.
         c) Adjustable short time pickup and delay.
         d) Ground fault pickup and delay.
         e) Arc flash reduction mode with external switch and indicator (1,200A and larger).
         f) Include shunt trip, undervoltage release, and other accessories where indicated.
         g) Display line currents and cause of trip.
      3) Conventional Thermal Magnetic Molded Case Branch Circuit Breakers: Circuit breakers with integral thermal and instantaneous magnetic trip in each pole.
      4) Circuit Breaker Accessories: Trip units and auxiliary switches as indicated.

7. Enclosure: NEMA PB 1, Type 4X cabinet box.
8. Cabinet Front: Flush and Surface cabinet front door-in-door type with concealed trim clamps, concealed hinge, metal directory frame, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel. Distribution panelboards larger than 400 amperes are not required to have door-in-door trims.

9. Other Available Features Required by Project:
   a. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.

b. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure.
c. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors must be sized for double-sized or parallel conductors as indicated on Drawings.
d. Do not mount neutral bus in gutter.
e. Doors: Door-in-door construction with concealed hinges; secured with flush or multipoint latch with tumbler lock; keyed alike. Outer door must permit full access to panel interior. Inner door must permit access to breaker operating handles and labeling, but current carrying terminals and bus must remain concealed.

2.3 METERING

A. Panelboards 400 amperes and larger shall be provided with a front mounted, digital power quality meter / analyzer package. The metering shall include simultaneous display of six (6) parameters including voltage, current, power, kVA, kVAR, power factor, frequency, kW demand, amperes demand, kWH, kVARH, auxiliary voltage input and neutral current. Phase switching shall be provided and the display shall indicate the phase being displayed. Provide all voltage and current transformers required to provide the above data.

B. Manufacturers: The power quality meter / analyzer package shall be:
1. Eaton PXE Tier 1.
2. General Electric/ABB.
3. Siemens.
4. Square D/Schneider.
5. Substitutions: refer to provisions of the General and supplemental General Conditions and Division 1 specification sections.

C. Install at 60” AFF to bottom of the meter case or, if the meter is to be installed above 60” AFF but no more than 78”AFF, provide an angle adapter to lower the meter viewing angle. Angle adapter shall be acceptable to the Architect/Engineer.

2.4 METERING TRANSFORMERS

A. Current Transformers: ANSI C57.13, 5 ampere secondary, bar or window type, with single secondary winding and secondary shorting device, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

B. Potential Transformers: ANSI C57.13, 120 volt secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

2.5 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to Owner spare parts, for repairing panelboards and related equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:

1. Keys: Two spares for each type of panelboard cabinet lock.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to panelboards and related equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards in accordance with NECA 407 and NEMA PB 1.1.

C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Panelboards: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NECA 407 and NEMA PB 1.1.
2. Consult Engineer for resolution of conflicting requirements.

C. Panelboards shall be installed in a manner to be fully compliant with the seismic restraint requirements of the North Carolina State Building Code. Provide mounting devices and hardware, bracing, fittings, etc. as required for seismic restraint. See Section 260010, Paragraph 1.24 for additional requirements.

D. Special Techniques:

1. Equipment Mounting:
   a. Attach panelboard to vertical finished or structural surface behind panelboard.
   b. Provide seismic control devices.
2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
3. Provide mounting and anchoring devices.
4. Height: 6 feet to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.
5. Mount panelboard cabinet plumb and rigid without distortion of box.

6. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
7. Install overcurrent protective devices and controllers not already factory installed.
    a. Set field-adjustable, circuit-breaker trip ranges.
    b. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver in accordance with manufacturer's published instructions.
8. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
9. Install filler plates in unused spaces.
10. Stub five 1 inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in future. Stub five 1 inch empty conduits into raised floor space or below slab not on grade. Identify each as SPARE.
11. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
12. Mount spare fuse cabinet in accessible location.

E. Interfaces with Other Work:

1. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components.

B. Install warning signs.

C. Panelboard Nameplates: Label each panelboard with engraved plastic nameplate.

D. Device Nameplates: Label each branch circuit device in power panelboards with nameplate.

E. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles must be located on interior of panelboard door.

F. Breaker Labels: Faceplate must list current rating, UL and IEC certification standards, and AIC rating.

G. Circuit Directory:

1. Provide directory card inside panelboard door, mounted in metal frame with transparent protective cover.
    a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.
2. Provide computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.

a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.

3. Create directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

3.4 FIELD QUALITY CONTROL

A. Quality Control: Field inspection, testing and adjusting shall be as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Provide performance testing of arc energy reduction systems as required by NEC Art. 240.87(C).

3.5 ADJUSTING

A. Contract Closeout: Adjust installed work as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Cleaning: Vacuum dirt and debris from panelboard tubs; do not use compressed air to assist in cleaning.

C. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

D. Adjust circuit breaker trip and time delay settings to values as required by the Coordination Study. Prior to final settings, adjust circuit breaker trip and time delay settings to minimum values that do not cause false tripping.

3.6 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature in accordance with manufacturer's published instructions.

END OF SECTION 262416

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SECTION 262419 – MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes MCCs for use with ac circuits rated 600 V and less, with combination controllers.

1.2 DEFINITIONS

A. CPT: Control power transformer.

B. MCC: Motor control center.

C. MCCB: Molded-case circuit breaker.

D. MCP: Motor-circuit protector.

E. OCPD: Overcurrent protective device.

F. PID: Control action; proportional plus integral plus derivative.

G. PT: Potential transformer.

H. SPD: Surge protective device.

I. SCR: Silicon-controlled rectifier.

J. VFC: Variable-frequency controller.

K. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for MCCs.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories for each cell of the MCC.

B. Shop Drawings: For each MCC, manufacturer's approval drawings as defined in UL 845. In addition to requirements specified in UL 845, include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.

1. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Each installed unit's type and details.
b. Factory-installed devices.
c. Enclosure types and details.
d. Nameplate legends.
e. Short-circuit current (withstand) rating of complete MCC, and for bus structure and each unit.
f. Features, characteristics, ratings, and factory settings of each installed controller and feeder device, and installed devices.
g. Specified optional features and accessories.

2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring for each installed controller.
3. Nameplate legends.
4. Vertical and horizontal bus capacities.
5. Features, characteristics, ratings, and factory settings of each installed unit.

1.4 INFORMATIONAL SUBMITTALS

A. Standard Drawings: For each MCC, as defined in UL 845.

B. Production Drawings: For each MCC, as defined in UL 845.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around MCCs where pipe and ducts are prohibited. Show MCC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Qualification Data: For testing agency.

E. Seismic Qualification Data: Certificates, for MCCs, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

F. Product Certificates: For each MCC.

G. Source quality-control reports.

H. Field quality-control reports.

I. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

J. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For MCCs, all installed devices, and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
2. Manufacturer's Record Drawings: As defined in UL 845. In addition to requirements specified in UL 845, include field modifications and field-assigned wiring identification incorporated during construction by manufacturer, Contractor, or both.
3. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
4. Manufacturer's written instructions for setting field-adjustable overload relays.
5. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage, solid-state controllers.
6. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
7. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or NICET.

1. Testing Agency's Field Supervisor: Certified by NETA or NICET to supervise on-site testing.

B. Source Limitations: Obtain MCCs and controllers of a single type from single source from single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, and marked for intended use.

D. UL Compliance: MCCs shall comply with UL 845 and shall be listed and labeled by a qualified testing agency.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver MCCs in shipping splits of lengths that can be moved past obstructions in delivery paths.

B. Handle MCCs according to the following:

1. NECA 402, "Recommended Practice for Installing and Maintaining Motor Control Centers."
2. NEMA ICS 2.3, "Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers Rated Not More Than 600 Volts."

C. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside MCCs; install temporary electric heating, with at least 250 W per vertical section.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace MCC that fail in materials or workmanship within specified warranty period.

1. Warranty Period: One year from date of Final Acceptance.

PART 2 - PRODUCTS

2.1 MOTOR-CONTROL CENTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB, Electrification Business.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; Schneider Electric USA.

2.2 SYSTEM DESCRIPTION

A. NEMA Compliance: Fabricate and label MCCs to comply with NEMA ICS 18.

B. Ambient Environment Ratings:

1. Ambient Temperature Rating: Not less than 0 deg F and not exceeding 104 deg F, with an average value not exceeding 95 deg F over a 24-hour period.
2. Ambient Storage Temperature Rating: Not less than minus 4 deg F and not exceeding 140 deg F
3. Humidity Rating: Less than 95 percent (noncondensing).
4. Altitude Rating: Not exceeding 6600 feet, or 3300 feet if MCC includes solid-state devices.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: MCCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."
2. Component Importance Factor: 1.5.
3. Component Amplification Factor: 2.5.
4. Component Response Modification Factor: 6.0.

B. Capacities and Characteristics:

1. MCC Enclosure and Assembly:

a. Nominal System Voltage: 480-V ac.
b. Service Equipment Rated: No.
c. Enclosure: NEMA 250, Type 1.

2. Integrated Short-Circuit Rating for MCC:
   a. Fully rated; 42 kA or higher if manufacturer's standard.

3. Integrated Short-Circuit Rating for Each Unit:
   a. Fully rated; 42 kA or higher if manufacturer's standard.

4. Wiring Class: NEMA ICS 18, Class II, Type C-S.
5. Bus:

   a. Horizontal Bus: 42 kA.
   b. Neutral Bus: 50 percent.

6. Main Disconnect Device:

   a. Main Disconnect: MCCB, UL 489, three pole.

7. VFCs:

   a. Tag Number: See schedule on Drawings.
      1) Overload Relays: Solid state. Class 10.
      2) Isolated Overload Alarm Contact: NO.

8. Controller-Mounted Auxiliary Devices:

   a. Push Buttons and Selector Switches: Heavy-duty, oiltight type.

2.4 MOTOR-CONTROL CENTER ENCLOSURES

A. Indoor Enclosures: Freestanding steel cabinets unless otherwise indicated. NEMA 250, Type 1–unless otherwise indicated to comply with environmental conditions at installed location.

B. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

C. Structure:

1. Comply with UL requirements for service entrance equipment.
2. Units up to and including Size 3 shall have drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
3. Units in Type B and Type C MCCs shall have pull-apart terminal strips for external control connections.

D. Compartments: Modular; individual doors with concealed hinges and quick-captive screw fasteners.

1. Interlock compartment door to require that the disconnecting means is "off" before door can be opened or closed, except by operating a concealed release device.

2. Compartment construction shall allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC.
3. The same-size compartments shall be interchangeable to allow rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.

E. Bus Transition and Incoming Pull Sections: Included and aligned with the structure of the MCC.

F. Interchangeability: Compartments constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC; same-size compartments to permit interchangeability and ready rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.

G. Wiring Spaces:

1. Minimum 4” Vertical wireways in each vertical section for vertical wiring to each unit compartment; supports to hold wiring in place.
2. 9” Horizontal wireways in bottom and top of each vertical section for horizontal wiring between vertical sections; supports to hold wiring in place.

H. Provisions for Future:

1. Compartments marked "future" shall be bused, wired and equipped with guide rails or equivalent, and ready for insertion of drawout units.
2. Compartments marked "spare" shall include provisions for connection to the vertical bus.

I. Integrated Short-Circuit Rating:
1. Short-Circuit Current Rating of MCC: Fully rated with its main overcurrent device; 42 kA.

J. Control Power:
1. 120-V ac; obtained from CPT integral with controller; with primary and secondary fuses. The CPT shall be of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.

K. Factory-Installed Wiring: Factory installed, with bundling, lacing, and protection included. Use flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

1. Wiring Class:
   a. NEMA ICS 18, Class II, Type C-S.

2. Control and Load Wiring: Factory installed, with bundling, lacing, and protection included. Use flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

L. Bus:

1. Main Horizontal and Equipment Ground Buses: Uniform capacity for entire length of MCC's main and vertical sections. Provide for future extensions.
2. Vertical Phase and Equipment Ground Buses: Uniform capacity for entire usable height of vertical sections, except for sections incorporating single units.
3. Phase- and Neutral-Bus Material:

a. Hard-drawn copper of 98 percent minimum conductivity or silver-plated alloy, with mechanical connectors for outgoing conductors.

4. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for ground conductors, minimum size 1/4-by-2 inches. Equip with mechanical connectors for outgoing conductors.
5. Neutral Disconnect Link: Bolted, uninsulated, 1/4-by-2-inch copper bus, arranged to connect neutral bus to ground bus.

2.5 MAIN DISCONNECT AND OVERCURRENT PROTECTIVE DEVICE(S)

A. MCCB: Fixed mounted, manually operated air-circuit breaker. Comply with UL 489.

1. MCCB shall have quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, its position shall be shown by the position of the handle, and manual push-to-trip push button.
2. Solid-state monitoring and tripping system to show system status monitoring, adjustable time-current protection, and shunt trip.

a. Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals or trip units with field-programmable ratings.
b. Trip-setting dials or interchangeable plugs to establish the continuous trip of the circuit breaker. Plugs shall not be interchangeable between frames, and the breaker may not be closed without the plug. With neutral ground-fault sensor.
c. Time-current adjustments to achieve protective-device coordination as follows:

1) Adjustable long-time delay.
2) Adjustable short-time setting and delay to shape the time-current curve.
3) Adjustable instantaneous setting.
4) Individually adjustable ground-fault setting and time delay.

d. Built-in connector to test the long-time delay, instantaneous, and ground-fault functions of the breaker.
e. Built-in digital ammeter display, showing load current and tripping cause.

B. Surge Suppression: Factory installed as an integral part of the incoming feeder, complying with UL 1449, SPD Type 2.

2.6 VFC

A. Controller Units: Combination controllers, consisting of variable-frequency power converter that is factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged for self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency. Comply with NEMA ICS 7, NEMA ICS 61800-2, UL 508C, and UL 508E.
1. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
2. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
3. Listed and labeled for single-phase use by an NRTL acceptable to authorities having jurisdiction.

B. Disconnects:

1. MCCB:

a. UL 489, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
c. Lockable Handle: For three padlocks and interlocks with cover in closed position.
d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.

2. Disconnect Rating:
a. Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
3. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.

C. Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 3 percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
4. Minimum Efficiency: 957 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.
6. Line Conditioning And Filtering:
a. Input Line Conditioning: Provide input filtering, as required, to limit THD(V) at input terminals of all VFCs to less than 5 percent.
b. Output Filtering: Provide output reactors for motor loads with more than 75 feet of feeder conductor length from the VFD output terminals to the motor terminal box or local disconnecting means.
c. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3.
7. Overload Capability:

a. For variable-torque controllers, 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
b. For constant-torque controllers, 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.

8. Starting Torque: Minimum of 100 percent of rated torque from 3 to 60 Hz.
9. Speed Regulation: Plus or minus 5 percent.
10. Output Carrier Frequency: Field selectable.
11. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
12. Internal Adjustability Capabilities:

a. Minimum Speed: 5 to 25 percent of maximum rpm.
b. Maximum Speed: 80 to 100 percent of maximum rpm.
c. Acceleration: 0.1 to 999.9 seconds.
d. Deceleration: 0.1 to 999.9 seconds.
e. Current Limit: 30 to a minimum of 150 percent of maximum rating.

13. Self-Protection and Reliability Features:
a. Loss of Input Signal Protection: Selectable response strategy including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
b. Under- and overvoltage trips.

c. Inverter overcurrent trips.
d. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved and listed and labeled by an NRTL.
e. Critical frequency rejection, with three selectable, adjustable deadbands.
f. Instantaneous line-to-line and line-to-ground overcurrent trips.
g. Loss-of-phase protection.
h. Reverse-phase protection.
i. Short-circuit protection.
j. Motor overtemperature fault.

14. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
15. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

D. Coordination with Life Support Systems Automation: Coordinate VFD control with Division 17 requirements.

E. Operator Station:

1. Inverter Logic: Microprocessor based.
2. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
3. Panel-mounted, manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

a. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
b. Security Access: Electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.

F. Displays:

1. Historical Logging Information and Displays:

a. Real-time clock with current time and date.
b. Running log of total power versus time.
c. Total run time.
d. Fault log, maintaining last four faults with time and date stamp for each.

2. Indicating Devices: Digital display mounted flush in VFC door and connected to display VFC parameters including the following:

a. Output frequency (Hz).
b. Motor speed (rpm).
c. Motor status (running, stop, fault).
d. Motor current (amperes).
e. Motor torque (percentage).
f. Fault or alarming status (code).

g. PID feedback signal (percentage).
h. DC-link voltage (V dc).
i. Set-point frequency (Hz).
j. Motor output voltage (V ac).

3. Overload Relays: Integral VFD overload protection.

G. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

H. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

I. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

J. Communication Port: USB 2.0 port or equivalent connection Capable of connecting a notebook computer.

2.7 CONTROLLER-MOUNTED AUXILIARY DEVICES

A. Control-Circuit and Pilot Devices: Factory installed in controller enclosure cover unless otherwise indicated. Comply with NEMA ICS 5.

1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oiltight type.

a. Push Buttons: Unguarded types; momentary contact unless otherwise indicated.
b. Pilot Lights: LED types; colors selected with submittals; push to test.
c. Selector Switches: Rotary type.

B. Elapsed-Time Meters: Heavy duty with digital readout in hours; nonresettable.

C. Auxiliary Dry Contacts: Reversible NC/NO.

D. Control Relays:

1. Time Delay: Auxiliary and adjustable solid-state time-delay relays.
2. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage protection via VFD onboard voltage protection.

2.8 METERING

A. Provide with a front mounted, digital power quality meter / analyzer package. The metering shall include simultaneous display of six (6) parameters including voltage, current, power, kVA, kVAR, power factor, frequency, kW demand, amperes demand, kWH, kVARH, auxiliary voltage input and neutral current. Phase switching shall be provided and the display shall indicate the phase being displayed. Provide all voltage and current transformers required to provide the above data.

B. Manufacturers: The power quality meter / analyzer package shall be:
   1. Eaton PXE Tier 1.
   2. General Electric/ABB.
   3. Siemens.
   4. Square D/Schneider.
   5. Substitutions: refer to provisions of the General and supplemental General Conditions and Division 1 specification sections.

C. Install at 60" AFF to bottom of the meter case or, if the meter is to be installed above 60" AFF but no more than 78"AFF, provide an angle adapter to lower the meter viewing angle. Angle adapter shall be acceptable to the Architect/Engineer.

2.9 METERING TRANSFORMERS

A. Current Transformers: ANSI C57.13, 5 ampere secondary, bar or window type, with single secondary winding and secondary shorting device, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

B. Potential Transformers: ANSI C57.13, 120 volt secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

2.10 SOURCE QUALITY CONTROL

A. MCC Testing: Test and inspect MCCs according to requirements in NEMA ICS 18.

B. VFC Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.

   1. Test each VFC while connected to its specified motor.
   2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

C. MCCs will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive MCCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. NEMA Industrial Control and Systems Standards: Comply with parts of NEMA ICS 2.3 for installation and startup of MCCs.

B. Floor Mounting: Install MCCs on 4-inch nominal-thickness concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Seismic Bracing: Comply with requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Install fuses in each fusible switch.

F. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."

G. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identification of MCC, MCC components, and control wiring.

1. Identify field-installed conductors, interconnecting wiring, and components.
2. Install required warning signs.
3. Label MCC and each cubicle with engraved nameplate.
4. Label each enclosure-mounted control and pilot device.
5. Mark up a set of manufacturer's connection wiring diagrams with field-assigned wiring identifications and return to manufacturer for inclusion in Record Drawings.

B. Operating Instructions: Frame printed operating instructions for MCCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of MCCs.

3.4 INSTALLATION OF CONTROL WIRING

A. Install wiring between master terminal boards and remote devices and facility's life support systems automation control system.

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control selection devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.

2. Connect selector switches within enclosed controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 CONNECTIONS

A. Comply with requirements for installation of conduit in Section 260533.13 "Conduits for Electrical Systems." Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections with the assistance of a factory-authorized service representative.

D. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Final Acceptance, but not more than 60 days after Final Acceptance, perform an infrared scan of each multipole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multipole enclosed controller 11 months after date of Final Acceptance.
    c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Submit calibration record for device.

5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
6. Mark up a set of manufacturer's drawings with all field modifications incorporated during construction and return to manufacturer for inclusion in Record Drawings.

F. MCCs will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to NETA Acceptance Testing Specification and manufacturer's written instructions.

3.8 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload relay pickup and trip ranges.

B. Adjust overload relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect/Engineer before increasing settings.

D. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage, solid-state controllers.

E. Program microprocessors in VFCs for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Final Acceptance.

F. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 “Power System Studies."

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers, and to use and reprogram microprocessor-based, reduced-voltage, solid-state controllers.

END OF SECTION 262419

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Wall switches.

B. Wall box dimmers.

C. Receptacles.

D. Wall plates.

E. Floor box service fittings.

F. Cord reels.

1.2 DESCRIPTION

Provide wiring devices in types, characteristics, grades, colors and electrical ratings for applications indicated which are third party testing agency listed and which comply with NEMA WD 1 and other applicable third party testing agency, NEMA and DSCC (Fed Spec) standards. All devices shall be produced by the same manufacturer.

1.3 RELATED SECTIONS

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other requirements applicable to the Work for electrical, communications, and electronic safety and security systems on Project, including wiring methods.

A. Section 260526 - Grounding and Bonding for Electrical Systems.

B. Section 260533.16 – Boxes and Covers for Electrical Systems.

C. Section 260553 – Identification for Electrical Systems.

1.4 REFERENCES

A. NECA - Standard of Installation.

B. NEMA WD 1 - General Requirements for Wiring Devices.

C. NEMA WD 6 - Wiring Device - Dimensional Requirements.

D. NFPA 70 - National Electrical Code.

E. Underwriters Laboratories (UL) 498.

F. DSCC (Fed Spec) W-C-596G

1.5 SUBMITTALS FOR REVIEW

A. Submittals: Procedures for submittals. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

1.6 SUBMITTALS FOR INFORMATION

A. Submittals: Submittals for information. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Submit manufacturer's installation instructions.

1.7 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

PART 2 - PRODUCTS

2.1 WALL SWITCHES

A. Manufacturers:
1. Hubbell Model 1221/2/3/4 Series.
2. Leviton 1221/2/3/4.
3. Pass and Seymour PS20AC1/2/3/4.
4. Substitutions: Refer to provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Description: NEMA WD 1, third party testing agency listed, DSCC, heavy-duty, AC only, general-use, grounding type, back and side wired, single pole, three-way and four-way as indicated, snap switch with hex-head equipment grounding screw. Switches shall have a steel, nickel plated bridge with integral ground, one piece rivetless copper alloy spring contact arm and terminal plate and large silver cadmium oxide contacts. All switches shall have quiet operating mechanisms without the use of mercury switches. All switches shall be approved by a third party agency, approved for the voltage and current indicated.

C. Body and Handle: Gray plastic with toggle handle.

D. Indicator Light: Neon lighted handle type switch; red color handle. Voltage per system rating.

E. Locator Light: Neon lighted handle type switch; green color handle. Voltage per system rating.

F. Ratings:
1. Voltage: 120-277 volts AC.
2. Current: 20 amperes.

2.2 WALL BOX INCANDESCENT DIMMERS

A. Manufacturers:
1. Lutron.
2. Leviton.
3. Arrow Hart.

4. Substitutions: Refer to provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Description: NEMA WD 1, third party testing agency, DSCC, Type I semiconductor dimmer for incandescent lamps.

C. Body and Handle: Gray plastic with preset slider.

D. Voltage: 120 volts.

E. Power Rating: Match load shown on drawings; 600 watts minimum at 80% maximum load.

2.3 WALL BOX LED 0-10V DIMMERS

A. Manufacturers:
1. Lutron DVSTV and DVTV.
2. Sensor Switch.
3. Wattstopper.
4. Substitutions: Refer to provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Description: NEMA WD 1, third party testing agency, DSCC Type I semiconductor dimmer for LED drivers. Provide line voltage or 0-10V to match lighting fixtures specified.

C. Body and Handle: Gray plastic with preset slider.

D. Switch Ratings:
1. Voltage: 120-277 volts AC.
2. Current: 8A minimum. Provide with 16A power pack for loads greater than 8A.

E. Voltage: 120 or 277 volts as required.

F. Power Rating: Match load shown on drawings.

2.4 RECEPTACLES

A. Manufacturers:
1. Hubbell Model HBL 5362 and HBL 5362TR.
2. Leviton 5362 and 5363-SGW.
3. Pass and Seymour 5362A and TR63.
4. Substitutions: Refer to provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Description: NEMA WD 1, third party testing agency, DSCC, heavy-duty, 20 ampere, 120 volt, general use, duplex, straight blade, grounding type receptacle arranged for back and side wiring, with separate single or double grounding terminals. Receptacles shall have a full wrap around brass bridge with integral ground and standup double wipe contacts. Self grounding or automatic type grounding receptacles are not acceptable in lieu of receptacles with separate grounding screw lugs and a direct, green insulated conductor connection to the equipment grounding system.

C. Device Face and Body: Gray nylon or reinforced thermoplastic.

D. Configuration: NEMA WD 6, type as specified and indicated.

E. Convenience Receptacle: Type 5-20R.

F. Provide tamper resistant devices where required by Codes.

2.5 USB RECEPTACLES

A. Manufacturers:
1. Hubbell Model USB20AC5.
2. Leviton T5833.
3. Pass and Seymour TR20USBAC6.
4. Substitutions: Refer to provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Description: NEMA WD 1, third party testing agency, DSCC, heavy-duty, 20 ampere, 120 volt, general use, duplex, straight blade, grounding type receptacle with Type A and C, 5A, 5V USB charging ports, arranged for back and side wiring, with separate single or double grounding terminals. Receptacles shall have a full wrap around brass bridge with integral ground and standup double wipe contacts. Self grounding or automatic type grounding receptacles are not acceptable in lieu of receptacles with separate grounding screw lugs and a direct, green insulated conductor connection to the equipment grounding system.

C. Device Face and Body: Gray nylon or reinforced thermoplastic. Provide red devices and plates where noted.

D. Configuration: NEMA WD 6, type as specified and indicated.

E. Convenience Receptacle: Type 5-20R.

F. Provide tamper resistant devices where required by Codes.

2.6 GROUND FAULT CIRCUIT INTERRUPTERS (GFI)

A. Manufacturers:
1. Hubbell Model GFR5362S.
2. Leviton G5362.
3. Pass and Seymour 2097TRWR.
4. Substitutions: Refer to provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Description: NEMA WD 1, third party testing agency, DSCC, heavy-duty, 20 ampere, 120 volt, general use, duplex, straight blade, grounding type receptacle arranged for back and side wiring, with separate single or double grounding terminals. Receptacles shall have a full wrap around brass bridge with integral ground and standup double wipe contacts. Self grounding or automatic type grounding receptacles are not acceptable in lieu of receptacles with separate grounding screw lugs and a direct, green insulated conductor connection to the equipment grounding system.

C. Device Face and Body: Gray nylon or reinforced thermoplastic.

D. Configuration: NEMA WD 6, type as specified and indicated.

E. Convenience Receptacle: Type 5-20R.

F. Provide tamper resistant devices where required by Codes.

2.7 WALL PLATES

A. Manufacturers:
1. Hubbell.
2. Leviton.
3. Pass and Seymour.
4. Substitutions: Refer to provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Decorative Cover Plate: Single and combination, of types, sizes and with ganging and cutouts as indicated. Provide plates which mate and match with wiring devices to which attached. Material shall be smooth, 0.04" thick, type 302 Stainless Steel as manufactured by the device vendor.

C. Weatherproof Cover Plate: Exterior mounted receptacles, and those noted to be weatherproof, shall be provided with weatherproof PVC transparent cover plates, standard size, and shall be single or ganged as indicated on the contract drawings. Weatherproof plates shall be "approved" third party listed as "raintight while in use".

D. Provide a minimum of 2% (not less than 2) spare cover plates of each type at project close-out.

2.8 CORD REELS

A. Manufacturers:
1. Hubbell Model HBL45123 Series.
2. Daniel Woodhead 92433 Series.
3. Reelcraft L5000 Series.
4. Substitutions: Refer to provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Description: Industrial duty, ceiling mounted, powder painted corrosion resistant steel cord reel with multi-position guide arm, positive latch mechanism maintaining desired cord length, spring rewind, ratchet lock, ball stop, 45 feet of 12/3 Type SJOW cord with two back to back 20A, 120V GFCI receptacles in yellow non-metallic, impact resistant pendant outlet box, third party testing agency listed, 20A, 120V power cord with twist lock plug. Receptacles shall be as specified above.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Ensure that outlet boxes are installed at proper height.

B. Ensure that wall openings are neatly cut and will be completely covered by wall plates.

C. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean debris from outlet boxes.

3.3 INSTALLATION

A. Install in accordance with NECA “Standard of Installation”.

B. Install devices vertically, plumb and level.

C. Install switches with OFF position down.

D. Install receptacles with grounding pole on top. Install horizontally oriented receptacles with the grounding pole on the left.

E. Receptacles installed over counters, backsplashes, etc., shall be mounted horizontally.

F. Install line voltage wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.

G. Do not share neutral conductor on load side of line voltage dimmers.

H. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.

I. Install decorative plates on switch, receptacle, and blank outlets in finished areas. Schedule installation of finish plates after the surface upon which they are installed has received final finish.

J. Connect switches by wrapping conductor around screw terminal.

K. Connect receptacles by utilizing back wiring provisions only. Do not use side wire terminals.

L. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets. Use cast box covers and plates on cast boxes.

M. Install protective rings on active flush cover service fittings.

N. Provide adhesive backed, laminated plastic receptacle device plate labels identifying the circuit feeding the device. Labels shall be label machine printed to indicate panel and circuit number and shall be Casio, Brother, T&B or approved equal. See Section 260553 for additional requirements

3.4 INTERFACE WITH OTHER PRODUCTS

A. Coordinate locations of outlet boxes provided under Section 260534 to obtain mounting heights specified and indicated on drawings.

B. All wiring devices shall be installed at heights as required by the ADA

C. Install wall switch 48 inches above finished floor, measured to top of device plate.

D. Install convenience receptacle 18 inches above finished floor, measured to bottom of device plate, unless noted otherwise on the Drawings.

E. Install convenience receptacle horizontally 6 inches above backsplash of counter, unless noted otherwise on the Drawings.

F. Install dimmer 48 inches (1.2 m) above finished floor, measured to top of device of plate.

G. Install telecommunications jack 18 inches (450 mm) above finished floor, measured to bottom of device plate, unless noted otherwise on the Drawings.

H. Install telephone jack for side-reach wall telephone to position top of telephone at 54 inches (1.4 m) above finished floor, unless noted otherwise on the Drawings.

I. Install telephone jack for forward-reach wall telephone to position top of telephone at 48 (1.2 m) above finished floor, unless noted otherwise on the Drawings.

3.5 FIELD QUALITY CONTROL

A. Quality Control. As required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Inspect each wiring device for defects.

C. Operate each wall switch with circuit energized and verify proper operation.

D. Verify that each receptacle device is energized.

E. Test each receptacle device for correct polarity and for ground continuity.

F. Test each GFCI receptacle device for correct operation.

3.6 ADJUSTING

A. Contract Closeout: Adjust installed work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Adjust devices and wall plates to be flush and level.

3.7 CLEANING

A. Contract Closeout: Clean installed work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION 262726

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SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Nonrenewable cartridge fuses.
2. Spare-fuse cabinets.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
2. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
3. Section 260573 "Power System Studies" specifies coordination studies, arc-flash hazard analysis, warning labels, and circuit-breaker trip ranges referenced by this Section.
4. Section 262816 “Enclosed Switches and Circuit Breakers” specifies switches and breakers referenced by this Section.

C. References:

1. NFPA 70 - National Electric Code.
2. NEMA FU 1 - Low Voltage Cartridge Fuses.

1.2 ACTION SUBMITTALS

A. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: For each type of product. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

    a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in electronic format suitable for use in coordination software and in PDF format.
5. Coordination charts and tables and related data.
6. Fuse sizes for elevator feeders and elevator disconnect switches.

1 1.3 PROJECT RECORD DOCUMENTS

2 A. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications
3 Sections.

4 B. Record actual fuse size.

5 1.4 QUALIFICATIONS

6 Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three
7 years documented experience.

8 1.5 MAINTENANCE MATERIAL SUBMITTALS

9 A. Extra stock material.

10 1. Provide no less than 10% of each fuse size and type installed, with a minimum of at least one set of three of
11 each.
12 2. Provide one fuse puller.

13 1.6 FIELD CONDITIONS

14 A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply
15 manufacturer's ambient temperature adjustment factors to fuse ratings.

16 PART 2 - PRODUCTS

17 2.1 PERFORMANCE REQUIREMENTS

18 A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by a qualified
19 electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and
20 application.

21 B. Dimensions and Performance: NEMA FU 1, Class as specified or indicated.

22 C. Voltage: Provide fuses with voltage rating suitable for circuit phase-to-phase voltage.

23 D. Third party testing agency Listed.

	Circuit Type	Fuse Type
1.	Service Entrance and Feeder Circuits over 600 Amp 200K Amp interrupting rating.	Class L
2.	Service Entrance and Feeder Circuits 600 Amp or less 200K Amp interrupting rating.	Class RK1 or J
3.	Motor, Motor Controller and Transformer Circuits 200K Amp interrupting rating.	RK5

31 E. For individual equipment where fault current does not exceed 50KA use Class K5 fuses with 50KA interrupting rating.

F. Fusible safety switches with short-circuit withstand ratings of 100KA or 200KA require Class R or Class J rejection fuse block feature.

2.2 NONRENEWABLE CARTRIDGE FUSES

A. Class J Nonrenewable Cartridge Fuse:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Bussmann, an Eaton business.
    b. Littelfuse, Inc.
    c. Mersen USA.
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by a qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
    a. Cartridge Fuses, Nonrenewable: UL CCN JDDZ, including UL 248-1 and UL 248-8 (Class J).
4. Standard Features:
    a. NEMA FU 1, Class J, 200 kA(sym) interrupt rating, current limiting, sizes up to 600 A, 600 V(ac), 8 to 10 s minimum time-delay at 500 percent, with rejection feature.

B. Class L Nonrenewable Cartridge Fuse:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Bussmann, an Eaton business.
    b. Littelfuse, Inc.
    c. Mersen USA.
2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by a qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
    a. Cartridge Fuses, Nonrenewable: UL CCN JDDZ, including UL 248-1 and UL 248-10 (Class L).
4. Standard Features:
    a. NEMA FU 1, Class L, 300 kA(sym) interrupt rating, current limiting, sizes 100 to 6000 A, 600 V(ac), 10 s minimum time-delay at 500 percent, with rejection feature, with bolt-on terminals.

C. Class RK1 Nonrenewable Cartridge Fuse:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Bussmann, an Eaton business.
b. Littelfuse, Inc.
c. Mersen USA.

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by a qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Cartridge Fuses, Nonrenewable: UL CCN JDDZ, including UL 248-1 and UL 248-12 (Class R).

4. Standard Features:

a. NEMA FU 1, Class RK1, 200 kA(sym) interrupt rating, current limiting, sizes up to 600 A, 600 V(ac), 8 to 10 s minimum time-delay at 500 percent, with rejection feature.

1) Select ferrule terminals or knife blade terminals to match equipment where fuse is installed.

D. Class RK5 Nonrenewable Cartridge Fuse:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Bussmann, an Eaton business.
b. Littelfuse, Inc.
c. Mersen USA.

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by a qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Cartridge Fuses, Nonrenewable: UL CCN JDDZ, including UL 248-1 and UL 248-12 (Class R).

4. Standard Features:

a. NEMA FU 1, Class RK5, 200 kA(sym) interrupt rating, current limiting, sizes up to 600 A, 600 V(ac), 8 to 10 s minimum time-delay at 500 percent, with rejection feature.

1) Select ferrule terminals or knife blade terminals to match equipment where fuse is installed.

2.3 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
2. Finish: Beige, baked enamel.

3. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

2.4 MAINTENANCE MATERIAL ITEMS

A. Extra Stock Material: Furnish to Owner extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Include the following:

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF FUSES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Work in Confined Spaces: NFPA 350.
5. Fuse Applications: NECA NEIS 420.
6. Work with Fuses in Motor Control Centers: NECA NEIS 402.

C. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

D. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

E. Install spare-fuse cabinet(s) in location indicated on the Drawings, typically in main electrical room or adjacent to the main service equipment.

F. Interfaces with Other Work:

1. Identification: Provide labels for spare fuse cabinet.

a. Legend: "SPARE FUSES" in 1-1/2 inch high letters on exterior of door.

2. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with results of coordination study and arc-flash hazard analysis.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Molded-case circuit breakers (MCCBs).
4. Enclosures.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
3. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
4. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.
5. Section 260573 "Power System Studies" for Short-circuit, Overcurrent protective device coordination, arc-flash hazard analysis and arc-flash label requirements.
6. Section 262813 “Fuses” specifies fuses referenced by this Section.

C. References:

1. NECA - Standard of Installation (published by the National Electrical Contractors Association).
2. NEMA AB 1 - Molded Case Circuit Breakers.
3. NEMA FU1 - Low Voltage Cartridge Fuses.
4. NEMA KS1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
5. NFPA 70 - National Electrical Code.

1.2 DEFINITIONS

A. GFEP: Ground-fault circuit-interrupter for equipment protection.

B. GFLS: Ground-fault circuit-interrupter for life safety.

C. SPDT: Single pole, double throw.

1.3 ACTION SUBMITTALS

A. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data:

1. For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
2. Enclosure types and details.
3. Current and voltage ratings.
4. Short-circuit current ratings (interrupting and withstand, as appropriate).
5. Include evidence of qualified electrical testing laboratory listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
7. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF and Insert calculation program format electronic format.
8. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

C. Shop Drawings: For enclosed switches and circuit breakers.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include wiring diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Contract Closeout: Submittals for project closeout. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Record actual locations of enclosed switches in project record documents.

C. Warranty documentation.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with NECA Standard of Installation.

B. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Source Limitations: Obtain products from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 RATINGS

A. Service Conditions:

1. Temperature: 104°F. (40°C.).
2. Altitude: N/A.
3. Terminal Rating: 75°C. minimum.

2.3 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB, Electrification Business.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; Schneider Electric USA.
5. Substitutions: As permitted in relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Type HD, Heavy Duty:
1. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Service-Rated Switches: Labeled for use as service equipment.
6. Hookstick Handle: Allows use of hookstick to operate handle.
7. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120 V(ac).

8. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.4 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB, Electrification Business.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; Schneider Electric USA.
5. Substitutions: As permitted in relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Type HD, Heavy Duty, Three Pole, Single Throw, 600 V(ac), 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Service-Rated Switches: Labeled for use as service equipment.
6. Hookstick Handle: Allows use of hookstick to operate handle.
7. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120 V(ac).
8. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.5 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB, Electrification Business.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; Schneider Electric USA.
5. Substitutions: As permitted in relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Circuit breakers must be constructed using glass-reinforced insulating material. Current carrying components must be completely isolated from handle and accessory mounting area.

C. Circuit breakers must have toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. Circuit-breaker handle must be over center, be trip free, and reside in tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon must be clearly marked on and off in addition to providing

international I/O markings. Equip circuit breaker with push-to-trip button, located on face of circuit breaker to mechanically operate circuit-breaker tripping mechanism for maintenance and testing purposes.

D. Maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings must be clearly marked on face of circuit breaker. Circuit breakers must be 100 percent rated or series rated as indicated on Drawings.

E. MCCBs must be equipped with device for locking in isolated position.

F. Lugs must be suitable for 75 deg C rated wire.

G. Standard: Comply with UL 489 with required interrupting capacity for available fault currents.

H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

J. Electronic Trip Circuit Breakers: Field-replaceable rating plug, RMS sensing, with the following field-adjustable settings:

1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.
4. Ground-fault pickup level, time delay, and I-squared t response.

K. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

L. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

M. GFLS Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6 mA trip).

N. GFEP Circuit Breakers: With Class B ground-fault protection (30 mA trip).

O. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
3. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
4. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.
5. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
6. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
7. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay

settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

8. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.
10. Electrical Operator: Provide remote control for on, off, and reset operations.
11. Accessory Control Power: Integrally mounted, self-powered.

2.6 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, UL 50E, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Finish: Enclosure must be NEMA-4X.

C. Conduit Entry: UL 50E Type 4X enclosures may not contain knockouts.

D. Operating Mechanism: Circuit-breaker operating handle must be externally operable with operating mechanism being integral part of box, not cover. Cover interlock mechanism must have externally operated override. Override may not permanently disable interlock mechanism, which must return to locked position once override is released. Tool used to override cover interlock mechanism must not be required to enter enclosure in order to override interlock.

E. Enclosures designated as UL 50E Type 4X stainless steel must have dual cover interlock mechanism to prevent unintentional opening of enclosure cover when circuit breaker is ON and to prevent turning circuit breaker ON when enclosure cover is open.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Commencement of work will indicate Installer's acceptance of areas and conditions as satisfactory.

3.2 SELECTION OF ENCLOSURES

A. Indoor, Dry and Clean Locations: UL 50E, Type 4X.

B. Outdoor Locations: UL 50E, Type 4X.

C. Wash-Down Areas: UL 50E, Type 4X.

D. Other Wet or Damp, Indoor Locations: UL 50E, Type 4X.

3.3 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Special Techniques:

1. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
2. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
3. Height: 5 feet AFF to operating handle.
4. Wall-mounted switches and circuit breakers shall be installed in a manner to be fully compliant with the seismic restraint requirements of the North Carolina State Building Code. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems." See Section 260010 “Supplemental Requirements for Electrical”, Paragraph 1.25 for additional requirements.
5. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
6. Install fuses in fusible disconnect switches serving Division 26 equipment.
7. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

3.4 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved laminated-plastic nameplate.

3.5 FIELD QUALITY CONTROL

A. Field inspection and testing shall be performed under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Inspect and test each circuit breaker to NEMA AB 1.

C. Inspect each circuit breaker visually.

D. Perform several mechanical ON-OFF operations on each circuit breaker.

E. Verify circuit continuity on each pole in closed position.

F. Determine that circuit breaker will trip on overcurrent condition, with tripping time to NEMA AB 1 requirements.

G. Include identification of each enclosed switch and circuit breaker tested and describe test results in test report.

3.6 ADJUSTING

A. Adjust work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

C. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 " Power System Studies." Prior to final settings, adjust circuit breaker trip and time delay settings to minimum values that do not cause false tripping.

3.7 PROTECTION

A. After installation, protect enclosed switches and circuit breakers from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.8 MAINTENANCE

A. Infrared Scanning of Enclosed Switches and Breakers: Two months after Final Acceptance, perform infrared scan of joints and connections. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.

1. Instruments and Equipment: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Follow-up Infrared Scanning: Perform two follow-up infrared scans of enclosed switches and breakers, one at four months and another at 11 months after Final Acceptance.
3. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
4. Report: Prepare certified report that identifies units checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 262816

SECTION 262913.03 - MANUAL AND MAGNETIC MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Manual motor controllers.
2. Enclosed full-voltage magnetic motor controllers.
3. Combination full-voltage magnetic motor controllers.
4. Enclosures.
5. Accessories.
6. Identification.

B. Related Requirements:

Section 262813 “Fuses” specifies fuses referenced by this Section.

C. References:

1. NECA (National Electrical Contractors Association) -Standard of Installation.
2. NEMA AB 1 (National Electrical Manufacturers Association) - Molded Case Circuit Breakers.
3. NEMA FU 1 (National Electrical Manufacturers Association) - Fuses.
4. NEMA ICS 2 (National Electrical Manufacturers Association) - Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated Not More Than 2000 Volts AC or 750 Volts DC.
5. NEMA ICS 5 (National Electrical Manufacturers Association) - Industrial Control and Systems: Control Circuit and Pilot Devices.
6. NEMA ICS 6 (National Electrical Manufacturers Association) - Industrial Control and Systems: Enclosures.
7. NEMA KS 1 (National Electrical Manufacturers Association) - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

1.3 DEFINITIONS

A. CPT: Control power transformer.

B. MCCB: Molded-case circuit breaker.

C. MCP: Motor circuit protector.

D. NC: Normally closed.

E. OCPD: Overcurrent protective device.

F. SCCR: Short-circuit current rating.

G. SCPD: Short-circuit protective device.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each type of magnetic controller.

1. Include plans, elevations, sections, and mounting details.
2. Indicate dimensions, weights, required clearances, and location and size of each field connection.
3. Wire Termination Diagrams and Schedules: Include diagrams for signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
4. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Product Schedule: List the following for each enclosed controller:

1. Each installed magnetic controller type.
2. NRTL listing.
3. Factory-installed accessories.
4. Nameplate legends.
5. SCCR of integrated unit.
6. For each combination magnetic controller include features, characteristics, ratings, and factory setting of the SCPD and OCPD.

    a. Listing document proving Type 2 coordination.

7. For each series-rated combination state the listed integrated short-circuit current (withstand) rating of SCPD and OCPDs by an NRTL acceptable to authorities having jurisdiction.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Seismic Qualification Data: Certificates, for magnetic controllers, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For magnetic controllers to include in operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Routine maintenance requirements for magnetic controllers and installed components.
b. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
c. Manufacturer's written instructions for setting field-adjustable overload relays.
d. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
e. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install temporary electric heating, with at least 50 W per controller.

1.9 FIELD CONDITIONS

A. Ambient Environment Ratings: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than23 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet for electromagnetic and manual devices.
3. The effect of solar radiation is not significant.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. UL Compliance: Fabricate and label magnetic motor controllers to comply with UL 508 and UL 60947-4-1.

C. NEMA Compliance: Fabricate motor controllers to comply with ICS 2.

D. Seismic Performance: Magnetic controllers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the controller will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Component Importance Factor: 1.5.

2.2 MANUAL MOTOR CONTROLLERS

A. Motor-Starting Switches (MSS): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ABB, Motion Business.
    b. Eaton.
    c. Siemens Industry, Inc., Energy Management Division.
    d. Square D; Schneider Electric USA.

2. Standard: Comply with NEMA ICS 2, general purpose, Class A.
3. Surface mounting.
4. Red pilot light.

B. Fractional Horsepower Manual Controllers (FHPMC): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ABB, Motion Business.
    b. Eaton.
    c. Siemens Industry, Inc., Energy Management Division.
    d. Square D; Schneider Electric USA.

2. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
3. Overload Relays: NEMA ICS 2, bimetallic class as schedule on Drawings.
4. Pilot Light: Red.

C. Integral Horsepower Manual Controllers (IHPMC): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABB, Motion Business.
b. Eaton.
c. Siemens Industry, Inc., Energy Management Division.
d. Square D; Schneider Electric USA.

2. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
3. Overload Relays: NEMA ICS 2, bimetallic class as scheduled on Drawings.

2.3 ENCLOSED FULL-VOLTAGE MAGNETIC MOTOR CONTROLLERS

A. Description: Across-the-line start, electrically held, for nominal system voltage of 600-V ac and less.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB, Motion Business.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; Schneider Electric USA.

C. Standard: Comply with NEMA ICS 2, general purpose, Class A.

D. Configuration: Nonreversing.

E. Contactor Coils: Pressure-encapsulated type.

1. Operating Voltage: Manufacturer's standard, unless indicated.

F. Control Power:

1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.

G. Overload Relays:

1. Thermal Overload Relays:

a. Inverse-time-current characteristic.
b. Class 10 tripping characteristic.
c. Heaters in each phase shall be matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
d. Ambient compensated.
e. Automatic resetting.

2.4 COMBINATION FULL-VOLTAGE MAGNETIC MOTOR CONTROLLER

A. Description: Factory-assembled, combination full-voltage magnetic motor controller consisting of the controller described in this article, indicated disconnecting means, SCPD and OCPD, in a single enclosure.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB, Motion Business.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; Schneider Electric USA.

C. Standard: Comply with NEMA ICS 2, general purpose, Class A.

D. Configuration: Nonreversing.

E. Contactor Coils: Pressure-encapsulated type.

1. Operating Voltage: Manufacturer's standard, unless indicated.

F. Control Power:

1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.

G. Overload Relays:

1. Thermal Overload Relays:

a. Inverse-time-current characteristic.
b. Class 10 tripping characteristic.
c. Heaters in each phase shall be matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
d. Ambient compensated.
e. Automatic resetting.

H. Class II ground-fault protection shall comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system shall include circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.

I. Digital communication module, using RS-485 Modbus, RTU protocol, 2-wire connection to host devices with a compatible port to transmit the following to the LAN:

1. Instantaneous rms current each phase, and 3-phase average.
2. Voltage: L-L for each phase, L-L 3-phase average, L-N each phase and L-N 3-phase average - rms.
3. Active Energy (kWh): 3-phase total.

J. Fusible Disconnecting Means:

1. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

K. Nonfusible Disconnecting Means:

1. NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

L. MCP Disconnecting Means:

1. UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

M. MCCB Disconnecting Means:

1. UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse-time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
2. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
3. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

2.5 ENCLOSURES

A. Comply with NEMA 250, Type 4X as indicated on Drawings, complying with environmental conditions at installed location.

B. The construction of the enclosures shall comply with NEMA ICS 6.

C. Controllers in hazardous (classified) locations shall comply with UL 1203.

2.6 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: Standard-duty, except as needed to match enclosure type. Heavy-duty or oil-tight where indicated in the controller schedule.

a. Push Buttons: As indicated in the controller schedule.
b. Pilot Lights: As indicated in the controller schedule.

2.7 IDENTIFICATION

A. Controller Nameplates: Laminated acrylic or melamine plastic signs, as described in Section 260553 "Identification for Electrical Systems," for each compartment, mounted with corrosion-resistant screws.

B. Arc-Flash Warning Labels:

1. Comply with requirements in Section 260573 "Power System Studies." Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.
2. Comply with requirements in Section 260553 "Identification for Electrical Systems." Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis. Labels shall be machine printed, with no field-applied markings.

    a. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

        1) Location designation.
        2) Nominal voltage.
        3) Flash protection boundary.
        4) Hazard risk category.
        5) Incident energy.
        6) Working distance.
        7) Engineering report number, revision number, and issue date.

    b. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wall-Mounted Controllers: Install magnetic controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems" unless otherwise indicated.

C. Floor-Mounted Controllers: Install controllers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

D. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

F. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

G. Setting of Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections with the assistance of a factory-authorized service representative.

E. Tests and Inspections:

1. Comply with the provisions of NFPA 70B, "Testing and Test Methods" Chapter.
2. Visual and Mechanical Inspection:

    a. Compare equipment nameplate data with drawings and specifications.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, and grounding.
    d. Verify the unit is clean.
    e. Inspect contactors:

        1) Verify mechanical operation.
        2) Verify contact gap, wipe, alignment, and pressure are according to manufacturer's published data.

    f. Motor-Running Protection:

        1) Verify overload element rating is correct for its application.
        2) If motor-running protection is provided by fuses, verify correct fuse rating.

    g. Inspect bolted electrical connections for high resistance using one of the two following methods:

        1) Use a low-resistance ohmmeter. Compare bolted connection resistance values with values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
        2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

3. Electrical Tests:

a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Insulation-resistance values shall be according to manufacturer's published data or NETA ATS Table 100.1. In the absence of manufacturer's published data, use Table 100.5. Values of insulation resistance less than those of this table or manufacturer's recommendations shall be investigated and corrected.
b. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
c. Test motor protection devices according to manufacturer's published data.
d. Test circuit breakers as follows:

1) Operate the circuit breaker to ensure smooth operation.
2) For adjustable circuit breakers, adjust protective device settings according to the coordination study. Comply with coordination study recommendations.

e. Perform operational tests by initiating control devices.

4. Infrared Inspection: Perform the survey during periods of maximum possible loading. Remove all necessary covers prior to the inspection.

a. Comply with the recommendations of NFPA 70B, "Testing and Test Methods" Chapter, "Infrared Inspection" Article.
b. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of each motor controller.
c. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each motor controller 11 months after date of Substantial Completion.
d. Report of Infrared Inspection: Prepare a certified report that identifies the testing technician and equipment used, and lists the following results:

1) Description of equipment to be tested.
2) Discrepancies.
3) Temperature difference between the area of concern and the reference area.
4) Probable cause of temperature difference.
5) Areas inspected. Identify inaccessible and unobservable areas and equipment.
6) Load conditions at time of inspection.
7) Photographs and thermograms of the deficient area.
8) Recommended action.

e. Equipment: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C. The equipment shall detect emitted radiation and convert detected radiation to a visual signal.
f. Act on inspection results and recommended action, and considering the recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

F. Motor controller will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

3.5 SYSTEM FUNCTION TESTS

A. System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality control tests have been completed and all components have passed specified tests.

1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
3. Verify the correct operation of sensing devices, alarms, and indicating devices.

B. Motor controller will be considered defective if it does not pass the system function tests and inspections.

C. Prepare test and inspection reports.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain electrical equipment.

END OF SECTION 262913.03

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SECTION 262923 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

B. Related Requirements:
1. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
2. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
3. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
4. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
5. Section 262419 "Motor Control Centers" for VFCs installed in motor control centers.
6. Section 262813 “Fuses” specifies fuses referenced by this Section.

1.2 DEFINITIONS

A. BAS: Building automation system.

B. CPT: Control power transformer.

C. DDC: Direct digital control.

D. EMI: Electromagnetic interference.

E. LAN: Local area network.

F. LED: Light-emitting diode.

G. NC: Normally closed.

H. NO: Normally open.

I. OCPD: Overcurrent protective device.

J. PID: Control action, proportional plus integral plus derivative.

K. RFI: Radio-frequency interference.

L. TDD: Total demand (harmonic current) distortion.

M. THD(V): Total harmonic voltage demand.

N. VFC: Variable-frequency motor controller.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFC indicated.

1. Include dimensions and finishes for VFCs.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each VFC indicated.

1. Include mounting and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Required working clearances and required area above and around VFCs.
2. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements.
3. Show support locations, type of support, and weight on each support.
4. Indicate field measurements.

B. Qualification Data: For testing agency.

C. Seismic Qualification Data: Certificates, for each VFC, accessories, and components, from manufacturer.

1. Certificate of compliance.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based, and their installation requirements.

D. Product Certificates: For each VFC from manufacturer.

E. Harmonic Analysis Report: Provide Project-specific calculations and manufacturer's statement of compliance with IEEE 519.

F. Source quality-control reports.

G. Field quality-control reports.

H. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

    a. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
    b. Manufacturer's written instructions for setting field-adjustable overload relays.
    c. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
    d. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
    e. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Indicating Lights: Two of each type and color installed.
4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Comply with NFPA 70.
4. IEEE Compliance: Fabricate and test VFC according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

1.8 DELIVERY, STORAGE, AND HANDLING

A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than 14 deg F (minus 10 deg C) and not exceeding 104 deg F (40 deg C).
   2. Ambient Storage Temperature: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C)
   3. Humidity: Less than 95 percent (noncondensing).
   4. Altitude: Not exceeding 100 feet.
   5. Provide sealed and gasketed NEMA 4X enclosures in outdoor locations.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.

   1. Warranty Period: Five years from date of Final Acceptance.

PART 2 - PRODUCTS

2.1 VARIABLE-FREQUENCY MOTOR CONTROLLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. Eaton.
   2. General Electric Company; GE Consumer & Industrial.
   3. Rockwell Automation, Inc.
   4. Schneider Electric USA, Inc.
   5. Siemens Industry, Inc., Building Technologies Division.

2.2 SYSTEM DESCRIPTION

A. General Requirements for VFCs:

   1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with NEMA ICS 7 and NEMA ICS 61800-2.

B. Application: Variable torque for compressors, fans and pumps.

C. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
   1. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
   2. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

E. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

F. Unit Operating Requirements:

   1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
   2. Input AC Voltage Unbalance: Not exceeding 5 percent.
   3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
   4. Minimum Efficiency: 96 percent at 60 Hz, full load.
   5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
   6. Minimum Short-Circuit Current (Withstand) Rating: 22 kA.
   7. Ambient Temperature Rating: Not less than 32 deg F and not exceeding 104 deg F.
   8. Humidity Rating: Less than 95 percent (noncondensing).
   9. Altitude Rating: Not exceeding 3300 feet.
   10. Vibration Withstand: Comply with NEMA ICS 61800-2.
   11. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
   12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
   13. Speed Regulation: Plus or minus 5 percent.
   14. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
   15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

G. Inverter Logic: Microprocessor based.

H. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.

   1. Signal: Electrical.

I. Internal Adjustability Capabilities:

   1. Minimum Speed: 5 to 25 percent of maximum rpm.
   2. Maximum Speed: 80 to 100 percent of maximum rpm.
   3. Acceleration: 0.1 to 999.9 seconds.
   4. Deceleration: 0.1 to 999.9 seconds.
   5. Current Limit: 30 to minimum of 150 percent of maximum rating.

J. Self-Protection and Reliability Features:

   1. Surge Suppression: Factory installed as an integral part of the VFC, complying with UL 1449 SPD, Type 1 or Type 2.

2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
6. Critical frequency rejection, with three selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor-overtemperature fault.

K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

L. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

M. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

O. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

P. Integral Input Disconnecting Means and OCPD: NEMA KS 1, fusible switch with pad-lockable, door-mounted handle mechanism.

1. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
2. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.
3. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: VFCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. The designated VFCs shall be tested and certified by an NRTL as meeting the ICC-ES AC 156 test procedure requirements.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.4 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.

    a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

C. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital display mounted flush in VFC door and connected to display VFC parameters including, but not limited to:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).

E. Control Signal Interfaces:

1. Electric Input Signal Interface:

    a. A minimum of six multifunction programmable digital inputs.

2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems:

a. 0- to 10-V dc.
b. 4- to 20-mA dc.
c. Potentiometer using up/down digital inputs.
d. Fixed frequencies using digital inputs.

3. Output Signal Interface: A minimum of one programmable analog output signal(s) (0- to 10-V dc), which can be configured for any of the following:

a. Output frequency (Hz).
b. Output current (load).
c. DC-link voltage (V dc).
d. Motor torque (percent).
e. Motor speed (rpm).
f. Set point frequency (Hz).

4. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

a. Motor running.
b. Set point speed reached.
c. Fault and warning indication (overtemperature or overcurrent).
d. PID high- or low-speed limits reached.

F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.

1. Number of Loops: As required. Coordinate with other trades.

G. Coordination with Division 17 Life Support Systems Automation: Coordinate VFD control with Division 17 requirements.

H. Interface with DDC System for HVAC: Factory-installed hardware and software shall interface with DDC system for HVAC to monitor, control, display, and record data for use in processing reports. VFC settings shall be retained within VFC's nonvolatile memory.

1. Hardwired Points:

a. Monitoring: On-off status, as required. Coordinate with other trades.
b. Control: On-off operation, as required. Coordinate with other trades.

2. Communication Interface: Comply with ASHRAE 135. Communication shall interface with DDC system for HVAC to remotely control and monitor lighting from a DDC system for HVAC operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the DDC system for HVAC.

2.5 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: Provide input filtering, as required, to limit THD(V) at input terminals of all VFCs to less than 5 percent.

B. Output Filtering: Provide output reactors for motor loads with more than 75 feet of feeder conductor length from the VFD output terminals to the motor terminal box or local disconnecting means.

C. EMI/RFI Filtering:

1. CE marked; certify compliance with IEC 61800-3.

2.6 BYPASS SYSTEMS (when required by other trades)

A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

B. Bypass Mode:

1. Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor, and retransfer shall only be allowed with the motor at zero speed.
2. Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic-control system feedback.

C. Bypass Controller:

1. Two-Contactor-Style Bypass: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.

    a. Bypass Contactor: Load-break, NEMA-rated contactor.
    b. Output Isolating Contactor: Non-load-break, NEMA-rated contactor.
    c. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

D. Bypass Contactor Configuration: Full-voltage (across-the-line) type.

1. NORMAL/BYPASS selector switch.
2. HAND/OFF/AUTO selector switch.
3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
4. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.

    a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
    b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.

    a. CPT Spare Capacity: 50 VA.

6. Overload Relays: Integral VFD overload protection.

E. Damper control circuit with end-of-travel feedback capability.

F. Sleep Function: Senses a minimal deviation of a feedback signal and stops the motor. On an increase in speed-command signal deviation, VFC resumes normal operation.

G. Motor Preheat Function: Preheats motor when idle to prevent moisture accumulation in the motor.

H. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

I. Remote digital operator kit.

J. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

2.7 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 4X.
2. Outdoor Locations: Type 4X.

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

2.8 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.

1. Push Buttons: Covered.
2. Pilot Lights: Push to test.
3. Selector Switches: Rotary type.
4. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

B. Reversible NC/NO bypass contactor auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage protection via VFD onboard voltage protection.

E. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

F. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

G. Cooling Fan and Exhaust System: For NEMA 250,Type NEMA-4X; UL 508 component recognized: Supply fan, with composite intake and exhaust grills and filters; 120-V ac; obtained from integral CPT.

H. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

I. Spare control-wiring terminal blocks; wired.

2.9 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.

1. Test each VFC while connected to its specified motor.
2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

B. VFCs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

C. Floor-Mounting Controllers: Install VFCs on 4-inch nominal thickness concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Roof-Mounting Controllers: Install VFC on roofs with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.

1. Curbs and roof penetrations are specified in Section 077200 "Roof Accessories."
2. Structural-steel channels are specified in Section 260529 "Hangers and Supports for Electrical Systems."

E. Equipment shall be installed in a manner to be fully compliant with the seismic restraint requirements of the North Carolina State Building Code. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems." See Section 260010 “Supplemental Requirements for Electrical”, Paragraph 1.25 for additional requirements.

F. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

G. Install fuses in each fusible-switch VFC.

H. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."

I. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.

J. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

K. Comply with NECA 1.

L. Install wiring from VFC to motor in conduit and locate the VFC within ten (10) feet and within sight of the motor.

3.3 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices and facility's central-control system. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.
2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

3.4 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFC with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections with the assistance of a factory-authorized service representative.

D. Acceptance Testing Preparation:

1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:

1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
7. Perform the following infrared (thermographic) scan tests and inspections, and prepare reports:

    a. Initial Infrared Scanning: After Final Acceptance, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Final Acceptance.

c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. VFCs will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect before increasing settings.

D. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Power System Studies."

E. Set field-adjustable pressure switches.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Final Acceptance.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION 262923

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SECTION 263213.13 – DIESEL-ENGINE-DRIVEN GENERATOR SETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Diesel-engine-driven generator sets.
2. Diesel engines.
3. Diesel fuel-oil system.
4. Control and monitoring.
5. Generator overcurrent and fault protection.
6. Generator, exciter, and voltage regulator.
7. Exhaust silencer.
8. Batteries.
9. Vibration isolation devices.
10. Day tanks.
11. Remote annunciators.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other requirements applicable to the Work for electrical, communications, and electronic safety and security systems on Project, including wiring methods.
2. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
3. Section 260529 "Hangers and Supports for Electrical Systems" specifies conduit hangers and supports referenced by this Section.
4. Section 260548 "Vibration and Seismic Controls for Electrical Systems."
5. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels.
6. Section 263213.14 “Generator Sets On-Board Paralleling Equipment”
7. Section 263600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine generators.
8. Section 265650 “Electrical Systems Commissioning.”

C. References:

1. NEMA AB1 - Molded Case Circuit Breakers.
2. NEMA MG1 - Motors and Generators.
3. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum.)
4. NFPA 30 - Flammable and Combustible Liquids Code.
5. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.
6. NFPA 70 - National Electrical Code.
7. NFPA 101 - Life Safety Code.
8. NFPA 110 - Emergency and Standby Power Systems.

1.2 DEFINITIONS

A. EPS: Emergency power supply.

B. EPSS: Emergency power supply system.

C. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.3 ACTION SUBMITTALS

A. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include thermal damage curve for generator.
4. Include time-current characteristic curves for generator protective device.
5. Include fuel consumption in gallons per hour at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
6. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
7. Include airflow requirements for cooling and combustion air in cubic feet per minute at 0.8 power factor, with air-supply temperature of 95, 80, 70, and 50 deg F. Provide Drawings indicating requirements and limitations for location of air intake and exhausts.
8. Include generator characteristics, including, but not limited to, kilowatt rating, efficiency, reactances, and short-circuit current capability.

C. Shop Drawings:

1. Include plans and elevations for engine generator and other components specified. Indicate access requirements affected by height of subbase fuel tank.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Identify fluid drain ports and clearance requirements for proper fluid drain.
4. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include base weights.
6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for engine generators and functional relationship between all electrical components.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Seismic Qualification Data: Certificates, for engine generator, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: With engine and generator mounted on rails, identify center of gravity and total weight including external silencer, and each piece of equipment not integral to the engine generator, and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Source Quality-Control Reports: Including, but not limited to, the following:

1. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
2. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
3. Report of sound generation.
4. Report of exhaust emissions showing compliance with applicable regulations.
5. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

D. Field quality-control reports.

E. Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

    a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
    b. Operating instructions laminated and mounted adjacent to generator location.
    c. Training plan.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: Two set each of lubricating oil, fuel, and combustion-air filters.
4. Tools: Each tool listed by part number in operations and maintenance manual.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with NFPA 110.

B. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

C. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Accept unit on site on skids. Inspect for damage.

B. Protect equipment from dirt and moisture by securely wrapping in heavy plastic.

1.9 WARRANTY

The Contractor shall provide the following minimum manufacturers factory warranty for each engine-generator set and associated equipment.

A. All equipment shall be new and warranted free of faulty workmanship and damage.

B. The warranty shall include all parts, labor (including travel with no travel time or distance limitations), expenses and equipment necessary to perform replacement and/or repairs.

C. The total system (parts and labor) shall be warranted free of defects for a period of one (1) year from date of final acceptance.

D. Replacement of defective materials and repair of faulty workmanship shall take place within 48 hours of notification by Owner and shall be guaranteed at no cost to the Owner during the warranty period.

E. The minimum warranty provisions specified above shall not diminish the terms of individual equipment manufacturer's warranties.

F. The printed warranty shall be included in the contract documents.

PART 2 - PRODUCTS

2.1 DIESEL-ENGINE-DRIVEN GENERATOR SETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Caterpillar, Inc.; Electric Power Division.
2. Cummins Power Generation.
3. Generac.
4. MTU Onsite Energy Corporation.

B. Source Limitations: Obtain packaged engine generators and auxiliary components from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Engine generator housing, day tank, engine generator, batteries, battery racks, silencers, accessories, and components shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Shake-table testing shall comply with ICC-ES AC156. Testing shall be performed with all fluids at worst-case normal levels.
3. Component Importance Factor: 1.5.

B. NFPA Compliance:

1. Comply with NFPA 37.
2. Comply with NFPA 70.
3. Comply with NFPA 110 requirements for Level 1 EPSS.

C. UL Compliance: Comply with UL 2200.

D. Engine Exhaust Emissions: Comply with EPA Tier 2 requirements and applicable state and local government requirements.

E. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: 41 to 104 deg F.
2. Relative Humidity: Zero to 95 percent.
3. Altitude: Sea level.

F. Unusual Service Conditions: Engine generator equipment and installation are required to operate under the following conditions:

1. High salt-dust content in the air due to sea-spray evaporation. Provide special coatings, high corrosion resistant hardware and components, anti-condensation heaters and alternator coatings suitable for the corrosive conditions at the site.

2.3 ENGINE GENERATOR ASSEMBLY DESCRIPTION

A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

C. EPSS Class: Engine generator shall be classified as a Class 48 according to NFPA 110.

D. Overload Capacity: 110 percent of service load for 1 hour in 12 consecutive hours.

E. Service Load: 1,250 kW / 1,562.5 kVA.

F. Power Factor: 0.8, lagging.

G. Frequency: 60 Hz.

H. Voltage: 277/480-V ac.

I. Phase: Three-phase, four wire, wye.

J. Induction Method: Turbocharged.

K. Governor: Adjustable isochronous, with speed sensing.

L. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and engine generator center of gravity.

M. Capacities and Characteristics:

1. Power Output Ratings: The generator set shall be capable of accepting a block load equal to the specified kW at 0.8 power factor at rated site conditions and recover to rated voltage and frequency. The alternator shall accept the largest load step with a maximum voltage dip of 25% based on the transient reactance of the alternator proposed. Provide documentation (with calculations if necessary) demonstrating compliance to this requirement.
2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

N. Engine Generator Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.

8. The generator set shall be designed and manufactured to be capable of being installed in an NFPA 110 Type 10 compliant EPSS (Emergency Power Supply System).

O. Paralleling Controls: See Section 263213.14.

2.4 DIESEL ENGINE

A. Fuel: ASTM D975, diesel fuel oil, Grade 2-D S15.

B. Rated Engine Speed: 1800 rpm.

C. Lubrication System: Engine or skid-mounted.

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

D. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with UL 499 and with NFPA 110 requirements for Level 1 equipment for heater capacity.

E. Integral Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, UV-, and abrasion-resistant fabric.

    a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and non collapsible under vacuum.
    b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

F. Muffler/Silencer:

1. Critical hockey puck type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

    a. Minimum sound attenuation of 25 dB at 500 Hz.

b. Sound level measured at a distance of 25 feet from exhaust discharge after installation is complete shall be 78 dBA or less.

G. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

H. Starting System: 24-V electric, with negative ground.

1. Components: Sized so they are not damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Performance Requirements" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level specified.
4. Battery: Lead acid, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least three times without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 50 deg F regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.
7. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the arrangement to minimize lengths of battery interconnections.
8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
9. Battery Charger: Current-limiting, automatic-equalizing, and float-charging type designed for lead-acid batteries. Unit shall comply with UL 1236 and include the following features:

a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 to 140 deg F to prevent overcharging at high temperatures and undercharging at low temperatures.
c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
f. Enclosure and Mounting: NEMA 250, Type 1, installed inside generator enclosure.

2.5 DIESEL FUEL-OIL SYSTEM

A. Comply with NFPA 37.

B. Piping: Fuel-oil piping shall be Schedule 40 black steel, complying with requirements in Section 231113 "Facility Fuel-Oil Piping." Cast iron, aluminum, copper, and galvanized steel shall not be used in the fuel-oil system.

C. Main Fuel Pump: Mounted on engine to provide primary fuel flow under starting and load conditions.

D. Fuel Filtering: Remove water and contaminants larger than 1 micron.

E. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

F. Fuel-Oil Storage Tank: Comply with requirements in Section 231323 "Facility Aboveground Fuel-Oil Storage Tanks."

1. Fuel Tank Capacity: 96 hours at 70% load of both generators.
2. Duplex Fuel-Oil Transfer Pump: Comply with requirements in Section 231213 "Facility Fuel-Oil Pumps."

G. Day Tanks: Comply with UL 142, freestanding, factory-fabricated fuel tank assembly, with integral, float-controlled fuel return pump and the following features:

1. Containment: Integral rupture basin with a capacity of 150 percent of nominal capacity of day tank.

    a. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak.

2. Tank Capacity: 150 gallons.
3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel supply pump at 110 percent of rated capacity, including fuel returned from engine.
4. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
5. High-Level Alarm Sensor: Liquid-level device operates alarm and redundant fuel shutoff contacts at midpoint between overflow level and 100 percent of normal fuel level.
6. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve.
7. Redundant High-Level Fuel Shutoff: Actuated by high-level alarm sensor in day tank to operate a separate motor-control device that disconnects day-tank pump motor. Sensor shall signal solenoid valve, located in fuel suction line between fuel storage tank and day tank, to close. Both actions shall remain in shutoff state until manually reset. Shutoff action shall initiate an alarm signal to control panel but shall not shut down engine generator.

2.6 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms. See Section 263213.14 for paralleling operation.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts engine generator. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

C. Provide minimum run time control set for 15 minutes with override only by operation of a remote emergency-stop switch.

D. Comply with UL 508A.

E. Configuration:

1. Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from engine generator vibration. Panel shall be powered from the engine generator battery.
2. Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common wall-mounted control and monitoring panel. Panel shall be powered from the engine generator battery.
3. Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator disconnect switch or circuit breaker, and other indicated components shall be grouped in a combination control and power panel. Control and monitoring section of panel shall be isolated from power sections by steel barriers. Panel shall be powered from the engine generator battery.

F. Control and Monitoring Panel:

1. Digital engine generator controller with integrated LCD display, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
2. Analog control panel with dedicated gages and indicator lights for the instruments and alarms indicated below.
3. Instruments: Located on the control and monitoring panel and viewable during operation.

    a. Engine lubricating-oil pressure gage.
    b. Engine-coolant temperature gage.
    c. DC voltmeter (alternator battery charging).
    d. Running-time meter.
    e. AC voltmeter, for each phase.
    f. AC ammeter, for each phase.
    g. AC frequency meter.
    h. Generator-voltage adjusting rheostat.

4. Controls and Protective Devices: Controls, shutdown devices, and common alarm indication, including the following:

    a. Cranking control equipment.
    b. Run-Off-Auto switch.
    c. Control switch not in automatic position alarm.
    d. Overcrank alarm.
    e. Overcrank shutdown device.
    f. Low-water temperature alarm.
    g. High engine temperature prealarm.
    h. High engine temperature.
    i. High engine temperature shutdown device.

j. Overspeed alarm.
k. Overspeed shutdown device.
l. Low fuel main tank.

1) Low-fuel-level alarm shall be initiated when the level falls below that required for operation for duration required for the indicated EPSS class.

m. Coolant low-level alarm.
n. EPS load indicator.
o. Battery high-voltage alarm.
p. Low cranking voltage alarm.
q. Battery-charger malfunction alarm.
r. Battery low-voltage alarm.
s. Lamp test.
t. Contacts for local and remote common alarm.
u. Low-starting air pressure alarm.
v. Low-starting hydraulic pressure alarm.
w. Remote manual stop shutdown device.
x. Air shutdown damper alarm when used.
y. Air shutdown damper shutdown device when used.
z. Generator overcurrent-protective-device not-closed alarm.
aa. Hours of operation.
bb. Auxiliary Relay: 3PDT, operates when engine runs, with contact terminals prewired to terminal strip.
cc. Additional visual indicators and alarms as required by NFPA 110.
dd. Remote Alarm Contacts: Pre wire SPDT contacts to terminal strip for remote alarm functions required by NFPA 110 for a Level 1 system.

G. Connection to Datalink:

1. A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication.
2. Provide connections for datalink transmission of indications to remote data terminals via ModBus.

H. Common Remote Panel with Common Audible Alarm: Include necessary contacts and terminals in control and monitoring panel. Remote panel shall be powered from the engine generator battery.

I. Remote Alarm Annunciator: An LED indicator light labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

1. Overcrank alarm.
2. Low water-temperature alarm.
3. High engine temperature prealarm.
4. High engine temperature alarm.
5. Low lube oil pressure alarm.
6. Overspeed alarm.
7. Low fuel main tank alarm.
8. Low coolant level alarm.
9. Low cranking voltage alarm.
10. Contacts for local and remote common alarm.

11. Audible-alarm silencing switch.
12. Air shutdown damper when used.
13. Run-Off-Auto switch.
14. Control switch not in automatic position alarm.
15. Lamp test.
16. Low-cranking voltage alarm.
17. Generator overcurrent-protective-device not-closed alarm.
18. Emergency stop switch.
19. Additional visual indicators and alarms as required by NFPA 110 for a Level 1 system.

J. Remote Emergency Stop Switch: Weatherproof, surface wall mounted, unless otherwise indicated, adjacent to the engine-generator set and labeled with an engraved, three layer, laminated plastic nameplate "GENERATOR EMERGENCY STOP". Push button shall be protected from accidental operation. See Drawings for location.

K. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator unless otherwise indicated.

2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Overcurrent protective devices shall be coordinated to optimize selective tripping when a short circuit occurs.

1. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.
2. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.

B. Generator Overcurrent Protective Device:

1. Insulated-case circuit breaker, electronic-trip type; 100 percent rated; complying with UL 489:

a. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
b. Trip Settings: Selected to coordinate with generator thermal damage curve.
c. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
d. Mounting: Adjacent to, or integrated with, control and monitoring panel.

C. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other engine generator protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector performs the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other engine generator malfunction alarms. Contacts shall be available for load shed functions.

2. Under single- or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the engine generator.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

D. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground fault.

1. Indicate ground fault with other engine generator alarm indications.
2. Trip generator protective device on ground fault.

2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide 12-lead alternator.

E. Range: Provide broad range of output voltage by adjusting the excitation level.

F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

G. Enclosure: Dripproof.

H. Instrument Transformers: Mounted within generator enclosure.

I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified and as required by NFPA 110.

1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.
2. Maintain voltage within 20 percent on one step, full load.
3. Provide anti-hunt provision to stabilize voltage.
4. Maintain frequency within 5 percent and stabilize at rated frequency within 2 seconds.

J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

L. Subtransient Reactance: 12 percent, maximum.

2.9 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

B. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment-mounting and -leveling bolt that acts as blocking during installation.
2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Minimum Deflection: 1 inch.

C. Comply with requirements in Section 232116 "Hydronic Piping Specialties" for vibration isolation and flexible connector materials for steel piping.

D. Comply with requirements in Section 233113 "Metal Ducts" for vibration isolation and flexible connector materials for exhaust shroud and ductwork.

E. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.

2.10 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.11 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with IEEE 115 and with NFPA 110, Level 1 Energy Converters.

B. Project-Specific Equipment Tests: Before shipment, factory test engine generator and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Test generator, exciter, and voltage regulator as a unit.
3. Full load run.
4. Maximum power.
5. Voltage regulation.
6. Transient and steady-state governing.
7. Single-step load pickup.

8. Safety shutdown.
9. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
10. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.

B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than two working days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

3.3 INSTALLATION

A. Comply with NECA 1 and NECA 404.

B. Comply with packaged engine generator manufacturers' written installation and alignment instructions and with NFPA 110.

C. Equipment Mounting:

1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
3. Install packaged engine generator with restrained spring isolators having a minimum deflection of 1 inch on 4-inch- high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

E. Exhaust System: Install Schedule 40 black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet.

1. Piping materials and installation requirements are specified in Section 232113 "Hydronic Piping."
2. Install flexible connectors and steel piping materials according to requirements in Section 232116 "Hydronic Piping Specialties."
3. Insulate muffler/silencer and exhaust system components according to requirements in Section 230719 "HVAC Piping Insulation."
4. Install isolating thimbles where exhaust piping penetrates combustible surfaces with a minimum of 9 inches of clearance from combustibles.

F. Drain Piping: Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40 black steel pipe with welded joints.

1. Piping materials and installation requirements are specified in Section 232113 "Hydronic Piping."
2. Drain piping valves, connectors, and installation requirements are specified in Section 232116 "Hydronic Piping Specialties."

G. Fuel Piping:

1. Diesel storage tanks, tank accessories, piping, valves, and specialties for fuel systems are specified in Section 231113 "Facility Fuel-Oil Piping."
2. Copper and galvanized steel shall not be used in the fuel-oil piping system.

H. Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow space for service and maintenance.

C. Connect cooling-system water piping to engine generator and with flexible connectors.

D. Connect engine exhaust pipe to engine with flexible connector.

E. Connect fuel piping to engines with a gate valve and union and flexible connector.

F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.

H. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

3.5 IDENTIFICATION

A. Identify system components according to Section 230553 "Identification for HVAC Piping and Equipment" and Section 260553 "Identification for Electrical Systems."

B. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.

3.6 FIELD QUALITY CONTROL

A. Testing Agency:
   1. Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
   2. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Tests and Inspections:

   1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in first two subparagraphs below, as specified in NETA ATS. Certify compliance with test parameters.

      a. Visual and Mechanical Inspection:

         1) Compare equipment nameplate data with Drawings and the Specifications.
         2) Inspect physical and mechanical condition.
         3) Inspect anchorage, alignment, and grounding.
         4) Verify that the unit is clean.

      b. Electrical and Mechanical Tests:

         1) Perform insulation-resistance tests according to IEEE 43.

            a) Machines Larger Than 200 hp: Test duration shall be 10 minutes. Calculate polarization index.
            b) Machines 200 hp or Less: Test duration shall be one minute. Calculate the dielectric-absorption ratio.

         2) Test protective relay devices.
         3) Verify phase rotation, phasing, and synchronized operation as required by the application.
         4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
         5) Perform vibration test for each main bearing cap.
         6) Verify correct functioning of the governor and regulator.

   2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here, including, but not limited to, single-step full-load pickup test.
   3. Perform and document the following additional testing:
      a. Commissioning: See Specifications Section 265650 - Electrical Systems Commissioning for requirements.
      b. Level 1 Acceptance Testing: Refer to NFPA 110 Section 7.13.2.1 Level 1 acceptance testing for requirements.

4. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

    a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
    c. Verify acceptance of charge for each element of the battery after discharge.
    d. Verify that measurements are within manufacturer's specifications.

5. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
6. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
7. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
8. Exhaust Emissions Test: Comply with applicable government test criteria.
9. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
10. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 and 100 percent of rated linear load. Verify that harmonic content is within specified limits.
11. Noise Level Tests: Measure A-weighted level of noise emanating from engine generator installation, including engine exhaust and cooling-air intake and discharge, at four locations 25 feet from edge of the generator building, and compare measured levels with required values.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Test instruments shall have been calibrated within the past 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.

G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

H. Remove and replace malfunctioning units and retest as specified above.

I. Retest: Correct deficiencies identified by tests and observations, and retest until specified requirements are met.

J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

K. Infrared Scanning: After Final Acceptance, but not more than 60 days after final acceptance, perform an infrared scan of each power wiring termination and each bus connection while running with maximum load. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Final Acceptance.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.7 DOCUMENTATION

A. Upon final completion of the system, a documentation package shall be provided and shall include three (3) bound (in three ring binders with index tabs) copies of complete manufacturer's operation and instruction manuals. Provide one bound original (no photocopies) and two additional bound copies (photocopies are acceptable) of the total documentation package. The manuals shall include operation and maintenance procedures, complete parts lists, dimensional drawings, unit wiring diagrams and schematics, and interconnection wiring drawings. Include instructions for routine maintenance requirements, service manuals for engine and day tank, oil sampling and analysis for engine wear, and emergency maintenance procedures. The following shall also be provided:

1. System record drawings.
2. Instruction manuals as supplied by the manufacturer for all components and electronics.
3. Product specification sheets for all equipment without instruction manuals.

3.8 CLEANING

A. Clean installed work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Touch up scratched or marred surfaces to match original finish.

C. Clean engine and generator surfaces. Replace oil and fuel filters.

3.9 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Final Acceptance, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's authorized service representative. Include quarterly preventive maintenance and exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Parts shall be manufacturer's authorized replacement parts and supplies.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

3.11 FINAL ACCEPTANCE

The installation shall be supervised, checked and tested by a qualified representative of the engine-generator set manufacturer. Written certification, by the qualified manufacturer's representative, verifying manufacturer's startup procedures were followed and full system functionality was achieved shall be submitted to the Architect and Owner prior to final acceptance.

END OF SECTION 263213.13

SECTION 262313.14 - GENERATOR SETS ON-BOARD PARALLELING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Project drawings and contract documents requirements apply to this section.

1.2 SUMMARY

A. This section describes requirements for paralleling two generator sets specified in Section 263213.13. Equipment provided shall be new factory assembled paralleling equipment with dedicated purpose microprocessor-based controls designed for fast, reliable operation and including the functions described herein. Generators and Paralleling Controls package shall be by the same Manufacturer.

B. Related sections of the project specifications include:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
2. Section 263213.13, Diesel-Engine-Driven Generator Sets.

1.3 DEFINITIONS

A. ATS: Automatic Transfer Switch

B. GFP: Ground Fault Protection.

C. HMI: Human-Machine Interface

D. PLC: Programmable Logic Controller. A device with associated accessory components that is designed to accept programmable inputs and provide completely field-programmable logically controlled outputs.

E. Manufacturer: The entity that maintains engineering design control for the equipment provided, provides service and maintenance documentation, provides service direction, and provides warranty support.

F. Supplier: The entity that provides manufacturer-authorized local sales and service support for the manufacturer’s equipment.

1.4 SUBMITTALS

A. Product Data: Provide the noted technical data for the controls equipment described in this section. Materials required include:

1. Technical data fully describing the critical design features of the equipment proposed, and substantiating compliance to the requirements of this specification. This material shall include 3rd party certifications and listing details for all equipment provided, including seismic certifications described herein.

2. Data shall include a complete description of the features and function of the proposed equipment, described on the manufacturer’s published literature or manufacturer’s letterhead with a manufacturer’s employee signature validating its accuracy.

3. Include a listing of all setting ranges and factory default settings.

B. Include a detailed sequence of operation for the specific equipment provided.

C. Shop Drawings: For each control enclosure or independent piece of equipment provide:

1. Elevation and other Drawings: Describing physical dimensions, weights, mounting provisions and requirements, mechanical and wiring access points.

2. Wiring Diagrams: Interconnecting wiring details including recommended control conduit configurations.

3. Submit names, qualifications, and locations of individuals who will service and support the equipment.

D. Source Quality Control Test Reports: Provide sample factory test report plan for integrated generator controls and paralleling system.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications

B. The paralleling equipment manufacturer shall be certified to ISO 9001 International Quality Standard

C. Source Limitations: The paralleling equipment shall be designed, manufactured, and warranted by the generator set manufacturer to provide a single source of responsibility for all the products provided. Warranty documents shall be provided verifying compliance to this requirement. Supplier shall directly employ service technicians specifically trained and qualified on the diagnosis and repair of engines, alternators, power transfer equipment, and paralleling equipment. The technicians shall be trained in the installation and commissioning of complex generator systems, including line voltage generator paralleling equipment. Manufacturer shall have more than (15) years' experience to ensure quality. Documentation for similar projects shall be provided upon request.

D. The paralleling system, including generator sets and paralleling equipment, shall be serviced by a single local service organization that is trained and factory certified in both generator set and paralleling equipment service. The technicians serving the site shall be specifically trained and certified by the manufacturer in the diagnosis and repair of the synchronizing, paralleling, and load sharing equipment provided. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.

E. The manufacturer shall maintain model and serial number records for the paralleling equipment for at least 20 years.

F. Equipment provided shall conform to the requirements of the following codes and standards to the extent that they are applicable:

1. UL 489 – Molded Case Circuit Breakers

2. EN55011, Class B Radiated Emissions

3. EN55011, Class B Conducted Emissions

4. IEC 1000-4-4 (EN 61000-4-4) Fast Transients Immunity

5. IEC 1000-4-2 (EN 61000-4-2) Electrostatic Discharge Immunity

6. IEC 1000-4-3 (EN 61000-4-3) Radiated Field Immunity

7. IEC 1000-4-6 Conducted Field Immunity

8. IEC 1000-4-11 Voltage Dip Immunity

9. NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.

10. NFPA110 – Emergency and Standby Power Systems. All equipment provided shall meet all requirements for Level 1 systems.

11. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Only approved bidders shall supply equipment provided under this contract. Equipment specifications for this project are based on microprocessor-based paralleling equipment manufactured by the generator manufacturer.

2.2 GENERATOR PARALLELING MONITOR AND CONTROL SYSTEM

A. Acceptable Manufacturers

1. See Section 263213.13.

B. Individual Generator Monitoring and Control Panel: Provide a paralleling control panel for each generator set in the emergency/standby power system. The paralleling control functions shall be integrated with the generator set control functions, and provided in a single, dedicated purpose microprocessor-based control designed and manufactured by the generator set manufacturer. Each paralleling control panel shall contain the functions as described in this section. No PLC-based control shall be used to provide these functions. Each paralleling control shall be independent and autonomous, requiring no interaction with other controls for proper operation, except load sharing and paralleling breaker status functions. Failure of the system master control shall have no impact on the functions described in this section for the generator sets.

1. Operator Panel. Each paralleling control shall be provided with an operator panel to allow the operator to view the status and control operation of the specific generator set being paralleled. The operator panel shall be provided with the following features and capabilities.

a. 1% or better accuracy generator set AC output instruments; Ammeter, Voltmeter, Frequency Meter, Wattmeter, KW-hour meter, Power Factor Meter, or other means shall be provided to allow viewing of voltage and amperes for each phase shall be provided. The voltmeter shall indicate line to line and line to neutral conditions. Voltmeter, ammeter, frequency meter, kW meter and power factor meter shall have both analog and digital displays. Switches and/or other provisions shall be included to allow reading of bus voltage and frequency from this metering set.

b. Synchronizer shall be an integral part of the multi-function digital generator set control. Independent synchronization swing panels are prohibited.

c. Running Time Meter, Start Counter

d. Generator Set Operator Panel: Panel shall provide manual and automatic functions for control of the generator set. Press the manual mode button to put the unit in manual mode if the operator does not press the Start button in 10 seconds, the control is put in the Off mode. Both manual and off modes prevent generator set from starting remotely or immediately shuts down the generator set if it is running. Press the auto mode button to put the unit in auto mode. The auto mode allows remote start, stop, breaker open, and breaker closed commands to be active. Generator controller must withstand voltage drops down to 8V DC upon engine starting.

e. Breaker trip/close switch with breaker status indicating lamps. The switch shall be interlocked with the control system such that breaker closure is not possible unless the mode select switch is in the run position and the generator set is synchronized with the system bus.

f. Control Reset push button switch with indicating lamp. Lamp shall flash to indicate that generator set is locked out due to a fault condition.

g. Lamp test push button switch. Operation of this switch shall cause all lamps on the panel to be simultaneously tested.

h. The control panel shall be provided with a set of DC-powered lamps with a switch to allow viewing of all functions on the front panel when normal lighting systems are not available.

i. Precision voltage and frequency raise lower function. The generator set frequency and voltage may be adjusted plus or minus 5% when the generator set is operating independently of the system bus. Voltage and frequency adjustments are integral to the generator set control, along with bus metering, breaker control switches, and manual paralleling controls for ease of use by the operator. The ability to make frequency and voltage adjustments shall be disabled when the paralleling breaker is closed. Voltage and frequency adjustments while the paralleling breaker is open shall not impact on the load sharing when the paralleling breaker is closed.

j. Alarm and status indicating panel to indicate the following conditions (alarm horn shall be located on master control)

2. Internal Controls. The following internal control functions shall be provided for each generator set in the system.

a. Electronic isochronous kW load sharing control to operate the engine governors during synchronizing and to provide isochronous load sharing when paralleled. The control system shall allow sharing of real kW load between all generator sets in the system to within 1% of equal levels, without introduction of frequency droop into the system. The control system shall include all equipment required for kW load sharing with an infinite bus. The infinite bus governing controls shall allow the generator set to synchronize to an infinite bus, parallel, and ramp up to a preset load level on the generator set. Additional controls shall be provided to cause the generator set to ramp up to a kW load level signaled by the system master control.

The isochronous load sharing module and engine governor shall be a coordinated system of a single manufacturer.

b. Load demand governing controls shall be provided to cause the generator set to ramp down to zero load when signaled to shut down in a load demand mode. On a signal to re-start, the load demand governing controls shall cause the generator set to synchronize to the system bus, close, and ramp up to it's proportional share of the total bus load. The ramp rate of the generator set shall be operator-adjustable.

c. Electronic kVAR load sharing control to operate the alternator excitation system while the generator set is paralleled. The control system shall allow sharing of reactive load between all generator sets in the system to within 1% of equal levels, without introduction of voltage droop into the system. The control system shall include all equipment required for VAR load sharing with an infinite bus in either a constant VAR or constant power factor mode for future application flexibility. (Mode and adjustments selectable by the operator)

d. Equipment shall be provided to monitor the generator set as it is starting, and verify that it has reached at least 90% of nominal voltage and frequency before closing to the bus. The equipment provided shall positively prevent out of phase paralleling if two or more engine generator sets reach operating conditions simultaneously by providing a lockout signal to disable breaker closure for generator set(s) in the system which have not been selected to be the first units to close to the bus. Controls to recognize the failure of the first breaker signaled to close, and allow system operation to proceed in spite of this failure shall also be provided (breaker failure alarm). Systems using dead bus relay schemes without a disable signal to positively prevent out of phase paralleling shall not be acceptable under this specification. System shall include an independent backup to automatically operate in the event that the primary system fails.

e. Synchronizer to electronically adjust the engine governor to match the voltage, frequency and phase angle of the bus. Synchronizer shall maintain the engine generator voltage within 1% of bus voltage and phase angle within 15 electrical degrees of the bus for 0.5 seconds before circuit breaker closing. Each unit shall have its own synchronizer; systems using a switching scheme to utilize a single system synchronizer will not be approved. Synchronizers and systems which utilize a motor driven pot for control of AC voltage during the synchronizing process will not be accepted. The system shall be provided with a fail to synchronize time delay that is adjustable from 10-120 seconds. Control logic for fail to synchronize function shall allow field adjustment of function for either alarm or shutdown of the generator set on failure condition.

f. Controls shall include a permissive relay function to assure that the generator set does not attempt to close out of phase with the bus, due to errant operation of the synchronizer.

g. Controls shall include a permissive (sync check) function, to be used with "generator synchronized" indicator during manual paralleling, to prevent accidental closure of the breaker with the generator set out of phase with the bus. Provisions to allow manual closure of the first generator set to a de-energized bus shall be included.

h. Controls shall be provided to verify generator set and bus phase rotation match prior to closing the paralleling breaker.

i. Electronic alternator overcurrent alarm and shutdown protection. This protection is required in addition to the overcurrent trip on the paralleling breaker, and shall sense current flow at the generator set output terminals. The overcurrent alarm shall be indicated when the load current on the generator set is more than 110% of rated current for more than 60 seconds. The overcurrent shutdown shall be matched to the thermal damage curve of the generator set, and shall not have an instantaneous function.

j. Electronic alternator short circuit protection. This protection is in addition to the overcurrent trip on the paralleling breaker. The short circuit shall occur when the load current on the generator set is more than 175% of rated current and an aggregate time/current calculation indicates that the system is approaching the thermal damage point of the alternator. The equipment used shall not have an instantaneous function and shall be selectively coordinated with the feeder circuit breakers. This protective function shall be provided by equipment that is UL-listed as a utility grade protective relay.

k. Provide overcurrent and short circuit protection for the conductors connecting the generator set to the distribution equipment. This protection may be integrated with alternator protection but must be positively coordinated to prevent tripping of the paralleling breaker prior to the operation of the alternator protective equipment.

l. Controls shall be provided to sense reverse VAR conditions on the alternator while paralleled to the system bus. Reverse VAR protection shall be set to operate at not less than 20% of the kVAR rating of the alternator at standby conditions. A reactive capability curve shall be provided to allow proper setting of this protection.

m. Generator set start contacts rated 10 amps at 32 VDC. A redundant network-based starting system shall also be provided.

n. Cooldown time delay, adjustable: 0-600 seconds. The control panel shall indicate the time remaining in the time delay period when the generator set is timing for shutdown.

o. Start time delay, adjustable: 0-300 seconds. The control panel shall indicate the time remaining in the time delay period when the generator set is timing for start.

p. Controls shall be provided to shut down generator set and initiate alarm when the generator set is at less than 85% of nominal voltage for more than 10 seconds, more than 110% of nominal voltage for more than 10 seconds. When the control is set to operate as Inverse time, the unit will be more sensitive to voltage spikes and trip more rapidly.

q. Provide all other components required, such as properly sized current transformers, transducers, terminal blocks, etc., for reliable system operation, as described herein under “SYSTEM OPERATION".

C. Master Control System and Monitoring Equipment: Provide an independent system master control to monitor and control the operation of the entire paralleling system.

1. Operator Panel. The master control panel shall be provided with at least a 15 Inch full color high resolution resistive touch Advantech HMI operator interface panel to allow

the operator to view the status and control operation of system. The operator panel shall be provided with the following features and capabilities.

a. Main One Line Screen shall give a graphical display of the power system components directly controlled by the paralleling system. System status displays a combination of multi-color animation, messages and pop-up indicators.

b. System Control Screen shall provide the operator with the ability to:

c. Load Control Screen shall allow the operator to monitor genset capacity, levels of load that have been added or shed.

   i. Allow the operator to manually shed or add loads levels.

   ii. Display the name, status and priority of each load block (whether on or off).

   iii. Display total load, as a percentage of online generation capacity, displays on a bar graph in kW and amps.

   iv. Display actual system load.

d. Bus metering display shall include the following parameters for each bus segment:

   i. Bus Line to Line voltage (all three phases simultaneously),

   ii. Bus Line to Neutral voltage (all three phases simultaneously),

   iii. Bus output current (all three phases simultaneously),

   iv. KW output of bus and as a percentage of rated KW,

   v. KVA,

   vi. KVAR,

   vii. KW hours

   viii. KVAR hours

   ix. Bus line to line voltage (all three phases simultaneously) (graphical format),

   x. Power Factor (graphical format), F

   xi. Bus output current (all three phases simultaneously) (graphical format),

e. KW output of bus, (graphical format) Frequency (graphical format).

   i. Selector buttons shall be provided to allow the user to choose which bus to monitor.

f. Active Alarm Screen shall display the date, time, alarm description and acknowledged date and time for genset and system alarms (alarm horn shall be located on master control).

g. Historical Alarm Log Screen shall display the date, time, alarm description and acknowledged date and time for genset and system alarms (alarm horn shall be located on master control). These alarms should be stored and displayed in the master control for x days or x alarms.

h. Real Time Trending Screen should monitor and display four pens simultaneously. Display parameters should include voltage, current, power, and frequency for each bus. Selector buttons shall be provided to allow the user to choose which bus to monitor.

i. Historical Trending Screen The system shall include historical trending which collects, displays, and stores data. The historical data base shall be a FIFO file with storage capacity up to 26 days, or saved to a USB flash drive. Data will be saved in ".csv" file format. Each trend pen will have stop/pause/zoom features to allow the operator to magnify the trend, and also scroll back in time to view history. Historical Trend properties shall include: Refresh rate = on data change or every 2 seconds Buffering for extra data = 360 data points Continuous scrolling with pause and sliding time Time span on display = 8 hours (normal view) Time span on display = 2 hours (zoon view) USB data storage = 1 Year (with Minimum 1 Gig) Maximum and Minimum scale values = selectable by operator via touch screen Print screen function Required Trend pens required: Total KW Total KVAR Average Amps Average L-L Voltage

j. User Login Security shall consist of 3 levels of security: Guest, Operator, and Technician. Automatic logout feature will reset access to “Guest” after defined period of time

k. Event Log Screen shall be capable of logging all breaker operations, security level changes, and system status changes with a time and date stamp.

l. The plant test report function shall provide a record that System generator sets have been operated above 30% load for a particular duration. The report shall be enabled individually for each generator set in the system. The report duration shall be adjustable between 5 – 240 minutes. The control will store at least 12 reports per generator. The operator may select, view, and print any and all of the 12 available reports per generator set. Reports shall be available via the remote web interface or FTP site. Each report shall contain the following information: Generator Set Name, Generator Set Model, 3 Phase L-L Voltage, 3 Phase Amps, Frequency, Power Factor, % KW, KW, KVAR, KVA, Oil Pressure, Coolant Temperature, Battery Voltage, Engine Hours

m. All screens shall have detailed help content

n. Diagnostic screens shall display: Operator panel diagnostics, Communications processor diagnostics and Primary controller diagnostics

o. Modbus TCP/IP over Ethernet for BMS Interface

2. Internal Controls. The following internal control components or functions shall be provided for the master control:

a. Load add and shed output contacts, rated 10 A at 250VAC/VDC. The priority level for each load shed contact set shall be field configurable through the master control operator panel.

b. The master functions shall include:

i. Automatic and manual start/stop commands for generator sets as well as paralleling breaker control.

ii. System test with and without load initiated locally or remotely

iii. Extended paralleling function includes peak shave and base load and may be initiated locally or remotely

iv. Bus Overload function used to initiate load shed.

3. Provide all other components required, such as properly sized current transformers, transducers, terminal blocks, etc., for proper and reliable system operation.

4. Master control equipment shall contain a system of diagnostic LED's to assist in analyzing proper system function.

D. Construction

1. Manufacturer shall supply drawings that note dimensions, access requirements, and conduit entry details.

2. The master control system shall be listed and labeled under the requirements of UL891 including all covers, barriers, and supports. Individual control sections shall be isolated from each other by metal or insulating barriers.

3. All wiring shall be IEC UL891 listed 105 deg C, 600 volt rated and sized as required. Each wire, device or function shall be suitably identified by silk screen or similar permanent identification.

4. The framework and all other sheet metal components of the system shall be primed with a rust inhibiting primer, and finished with two coats of satin finish ANSI 61 gray enamel and must meet corrosion requirements of IEC 61439

5. All door mounted control components shall be industrial type oil tight devices with contact ratings a minimum of twice the maximum circuit ampacity they are controlling. Toggle switches and other light duty control devices are not acceptable. Indicator lamps shall be high intensity LED type devices. Indicator lamp condition (on or off) shall be easily visible in bright room lighting conditions.

6. AC control circuits in the switchboard shall be protected with properly sized fuses or circuit breakers,. Potential transformers shall be protected on line and load side.

7. All CT installations shall include 6 place shorting type terminal blocks using 12 gauge wire with ring terminal connectors.

8. All field control interconnect wiring shall be sized as specified by system manufacturer (wiring not designated by the system manufacturer shall be minimum 14 AWG copper). All control interconnect wiring shall be stranded.

9. All active control system components in the system shall be suitable for operation in ambient temperatures ranging from 0 to +50 degrees C. The controls shall be suitable for operation in an ambient ranging from 5-95% relative humidity, and shall be protected from the effects of equipment vibration.

10. The Touchscreen and other non-LED displays specified shall be suitable for operation from 0-50 degrees C. The controls shall be suitable for operation in an ambient ranging from 5-95% relative humidity.

E. System Control Power

1. Control power for the paralleling system controls shall be derived from the generator set 24VDC starting batteries. A solid state, no break "best battery" selector system shall be provided so that control voltage is available as long as any battery bank in the system is available, and that all battery banks are isolated to prevent the failure of one battery from disabling the entire system. The power transfer control shall be supplied with redundant DC control power from two independent sources.

2. The generator set governing, voltage regulation, load sharing, synchronizing, and protection, shall be capable of proper operation with battery voltage levels down to 8vdc without external battery support. The master control shall be supplied with a station battery system rated to 10 amp minimum. The control power for the system master controls shall be derived from at least two different sets of generator set battery banks.

3. Paralleling breaker control power for each paralleling breaker shall be derived from the generator set for opening, and closing the breakers.

F. SEQUENCE OF OPERATION

1. Normal Standby Conditions: Genset Breakers are open and the Gensets are not running. System loads are supplied by the normal source and may be controlled manually or by a building management system.

2. Loss of Normal Power: The DMC and Gensets receive a start signal from an automatic transfer switch. The Gensets start automatically and independently and accelerate to rated voltage and frequency. The first Genset closes to the bus as dictated by the First Start System. The remaining Genset synchronizes to the Load Bus and close its respective Genset breaker. The Gensets proportionally share load on the Load Bus. The Load Demand feature will operate if it is enabled.

3. Return of Normal Power: The ATSs remove the start signal from the DMC and Gensets. The Genset Breakers open. The Gensets run in cool down mode and then shutdown. The system returns to a Standby mode of operation.

4. Test Without Load: The operator initiates this sequence by selecting the Test Without Load checkbox on the System Control screen. The Gensets start automatically, independently and accelerate to rated voltage and frequency. The first Genset closes to the bus as dictated by the First Start System. The remaining Genset synchronizes to the Load Bus and close its respective Genset Breaker. The Load Demand feature will operate if it is enabled. The operator returns the system to Standby mode from Test Without Load by selecting the Off checkbox on the System Control Screen. The Genset Breakers open. The Gensets run in cool down mode and then shutdown. The system returns to Standby mode of operation.

5. Genset Bus Overload: The Genset bus overload condition occurs when an operational Genset is either at or below 57 Hz for three seconds or at 105% of load for 60 seconds. If Genset bus overload condition occurs, a bus overload alarm initiates on the DMC. The second Genset starts and when synchronized closes its circuit breaker to the bus.

6. Failure Modes

    a. Fail to Start If a unit fails to start after the overcrank time delay (time set in the genset control) expires, the unit shuts down and an alarm sounds on the DMC. The operator needs to check and rectify the problem on the Genset at this stage.

b. Fail to Synchronize If a unit fails to synchronize after a preset time delay, an alarm sounds and the unit continues attempting to synchronize until signaled to stop by an operator either on the PCC or on the Genset Control Screen of the HMI on the Digital Master Control.

7. Run Hours Based Sequence Method: In this mode, the control automatically select the shutdown sequence for the generator sets based on the engine run hours of the Genset, and restarts generators sets in the opposite order. Again, the generator set as the lead or preferred unit never shuts down. The control balances the run hour of the generator sets by creating a sequence based on the current run hours of the generator sets. The generator set with the fewest run hours is set as the lead generator set. The control never shuts down the lead generator set. The generator set with most run hours is the first generator set that will be shut down. The control changes the generator shut down sequence to balance the run hours, based on a threshold set by the operator at the HMI Touch Screen. When the difference in run hours between two generator sets is greater than the threshold, the control switches the two generator sets in the sequence. To initiate the run hour-based load demand sequence, the operator must navigate to the system control screen and check the load demand 'ON ENGINE HOURS' check box. The engine run hours can be monitored from the Genset Summary Screen. Upon detection of the lead or preferred Genset failure, the alternative Genset will immediately start and transfer to the bus, releasing the other Genset for maintenance There are two-time delays associated with the Load Demand feature. • The Initial time delay is the time delay the DMC waits for the system loads to stabilize before monitoring the load to see if Gensets can be shut down. • The Shutdown time delay is the time delay the DMC waits before issuing a Load Demand Stop to a generator while load conditions are such that the next Genset in the Load Demand sequence should be shutdown. The system returns to the normal load demand sequence described above.

8. Priority Based Load Control

a. Load Add Sequence: The Load Add feature allows the system to have each distribution device assigned to a Load Add Level in the range from 1-8. The amount of load assigned to each load level should be less than the capacity of the smallest sized Genset in the system. More than one distribution device can be assigned to a load add level. When the first Genset Connects to the Load Bus, all distribution devices assigned to load add level 1 will be commanded to add. When the second Genset Connects to the Load Bus, all distribution devices assigned to load add level 2 will be commanded to add. This sequence continues until all Gensets have been added to the Load Bus. If there are more load add levels than Gensets in the system, the DMC will continue to add load levels on a time delay basis until all load add levels in use in the system are added. In the event that not all existing Gensets connect to the Load Bus, the DMC will only add load levels equal to the number of Gensets online. Any further load add levels will need to be added using the manual commands from the Load Control screen. If during the manual adding of load levels, an overload condition occurs, the system will start the Load Shed sequence.

b. Load Shed Sequence: The Load Shed feature allows the system to have each distribution device in the system to be assigned a load shed level in the range from 0-7. Load Shed level assignment can be automatically done by the DMC based upon the load add level assignments, or can be user defined. Load Shed level 0 will never shed and should be used for critical loads. Load Shed level 1 is the first

load to shed when an overload condition has been detected. The load shed feature is activated when the generator detects an overload condition. An overload condition occurs when a PCC of an operational genset senses a frequency at or below 57 Hz for three seconds or at 105% of load for 60 seconds. Upon receiving an overload condition from one or more Gensets, the DMC starts an overload timer. When this timer expires, all distribution devices assigned to Load Shed level 1 open. If the system is still in an overload condition, the DMC waits a time delay (2 Sec) and all Feeder Breakers assigned to Load Shed level 2 open. This sequence continues until the overload condition clears. Once the overload condition is reset, Load Levels may be restored manually using the Restore pushbuttons on the Load Control screen. If during the manual restore of load levels, an overload condition occurs, the system will again start the Load Shed sequence.

PART 3 - Execution

3.1 EXAMINATION

A. The installer shall be responsible for inspection of the site and verification that the equipment can be installed and operated as required by the manufacturer.

3.2 INSTALLATION

A. The equipment shall be installed as recommended by the equipment manufacturer.

B. Remove temporary lifting provisions prior to commissioning.

3.3 IDENTIFICATION

A. Mount permanent operating instructions at each transfer point, and at the system master control. Instructions shall include a one-line system drawing, description of the operating sequences of the system and the manual operation instructions for the panel where they are installed.

B. A notice indicating location of the operation and maintenance manual shall be provided.

C. A notice indicating service support information including supplier name, telephone numbers, and manufacturer’s contact information shall be provided on each major piece of equipment.

3.4 CONNECTIONS

A. Ground each piece of equipment according to the requirements elsewhere in Division 26 “Grounding and Bonding for Electrical Systems”, and in compliance with instructions in the drawings.

B. Connect power conductors in compliance to appropriate instructions based on voltage class, elsewhere in Division 26.

C. Provide control interconnection wiring and connect all control interconnections in strict compliance to the equipment manufacturers’ instructions.

3.5 FIELD QUALITY CONTROL

A. Prior to acceptance testing, test insulation resistance of each bus, component, connecting supply, feeder, and control circuit (in compliance with equipment manufacturer(s).) Test continuity of each circuit. Retain permanent records of this testing.

B. A factory-authorized and certified service technician shall inspect all control wiring for type of wiring material and installation practice, verify that the wiring is properly installed by point-to-point testing, and complete installation and startup checks as required by the equipment manufacturer.

ADJUSTING

C. Set all protective relaying according to the results as required by a coordination study. Set all other settings as recommended by the equipment manufacturer.

D. Record all settings and provide in system operation and maintenance manuals.

3.6 CLEANING

A. All equipment is to be thoroughly cleaned, with any shipping or installation damage repaired, prior to equipment commissioning and final test.

3.7 PROTECTION

A. Equipment shall be protected from the environment in compliance to manufacturer's recommendations. As a minimum, equipment shall be protected from moisture, dirt, and condensation.

3.8 DEMONSTRATION

A. Factory Testing. Before shipment of the equipment to the jobsite, the entire control system (including generator set controls) shall have sequence of operation tested at the manufacturer's facility to demonstrate that it is fully functional prior to shipment to the jobsite. No exceptions to the requirements of this paragraph will be accepted.

B. Factory acceptance testing shall be executed successfully prior to shipment from factory.

C. The supplier of the paralleling system shall provide a manufacturer-certified representative to train the Owner's personnel in the proper operation and maintenance of the paralleling system.

END OF SECTION 262313.14

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SECTION 263600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Contactor-type automatic transfer switches.
2. Transfer switch accessories.

B. Related Sections:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other requirements applicable to the Work for electrical, communications, and electronic safety and security systems on Project, including wiring methods.
2. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
3. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers and supports referenced by this Section.
4. Section 260548 "Vibration and Seismic Controls for Electrical Systems."
5. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
6. Section 265650 “Electrical Systems Commissioning.”
7. Section 263213.13 “Diesel-Engine-Driven Generator Sets”
8. Section 263213.14 “Generator Sets On-Board Paralleling Equipment.”

C. References:

1. NEMA ICS 10 - AC Transfer Switch Equipment.
2. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (International Electrical Testing Association).
3. NFPA 70 - National Electrical Code.

1.2 ACTION SUBMITTALS

A. Submit under provisions of relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data:

1. Contactor-type automatic transfer switches.
2. Transfer switch accessories.

C. Product Data Submittals: For each product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.
2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.

D. Shop Drawings:

1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
2. Include material lists for each switch specified.
3. Single-Line Diagram: Show connections between transfer switch, Power sources, and load.
4. Riser Diagram: Show interconnection wiring between transfer switches, annunciators, and control panels.

1.3 INFORMATIONAL SUBMITTALS

A. Submit under provisions of relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

C. Qualification Data: For manufacturer-authorized service representative.

D. Seismic Qualification Data: Certificates, for transfer switches, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

    a. Features and operating sequences.
    b. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.5 QUALITY ASSURANCE

A. Conform to requirements of NFPA70.

B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of Project.

C. Supplier Qualifications: Authorized distributor of specified manufacturer with minimum three years documented experience.

1.6 MAINTENANCE SERVICE

Provide service and maintenance of transfer switches for one year from Date of Final Acceptance.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from Date of Final Acceptance. The warranty shall include all parts, labor (including travel), expenses and equipment necessary to perform replacement and repairs.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NEMA ICS 1.

C. Comply with NFPA 110.

D. Comply with UL 1008 unless requirements of these Specifications are stricter.

E. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

F. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
2. Short-time withstand capability for 3 cycles.

G. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

H. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

I. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.

J. Neutral Switching: Provide overlapping neutral contacts.

K. Neutral Terminal: Fully rated unless otherwise indicated.

L. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

M. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable markers at terminations. Color-coding and wire and cable markers are specified in Section 260553 "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
4. Accessible via front access.

N. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated. Finish shall be Manufacturer's standard gray enamel.

O. Generators Start Circuit Integrity Monitoring for ATS-4LS: Provide start circuit integrity monitoring as required by NFPA 70 Article 700.10 (D)(4). Loss of integrity must start the generators.

2.2 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB Electrification Installations Products.
2. ASCO.
3. Caterpillar, Inc.; Electric Power Division.
4. Cummins Power Generation.
5. Eaton.
6. Generac.
7. Substitutions: As permitted in relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Comply with Level 1 equipment according to NFPA 110.

C. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are unacceptable.
2. Switch Action: Double throw; mechanically held in both directions.

3. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.
4. Conductor Connectors: Suitable for use with conductor material and sizes.
5. Material: Hard-drawn copper, 98 percent conductivity.
6. Main and Neutral Lugs: Mechanical type.
7. Ground Lugs and Bus-Configured Terminators: Mechanical type.
8. Ground bar.
9. Connectors shall be marked for conductor size and type according to UL 1008.

D. Automatic Closed-Transition Transfer Switches: Connect both sources to load momentarily. Transition is controlled by programming in the automatic transfer-switch controller.

1. Fully automatic make-before-break operation when transferring between two available power sources.
2. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms.
3. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.

    a. Initiation occurs without active control of generator.
    b. Automatic transfer-switch controller takes active control of generator to match frequency, phase angle, and voltage.
    c. Controls ensure that closed-transition load transfer closure occurs only when the two sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.

4. Failure of power source serving load initiates automatic break-before-make transfer.

E. Manual Switch Operation, Load-Breaking: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

F. Manual Switch Operation, Non-Load-Breaking: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

G. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.

H. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

I. Automatic Transfer-Switch Controller Features:

1. Controller operates through a period of loss of control power.
2. Undervoltage Sensing for Each Phase of Normal and Alternate Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.

4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts:

    a. Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
    b. Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.

12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is unavailable.

J. Large-Motor-Load Power Transfer:

1. In-Phase Monitor: Factory-wired, internal relay controls transfer so contacts close only when the two sources are synchronized in phase and frequency. Relay shall compare phase relationship and frequency difference between normal and emergency sources and initiate transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer shall be initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
2. Motor Disconnect and Timing Relay Controls: Designated starters in loss of power scenario shall disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters shall be through wiring external to automatic transfer switch. Provide adjustable time delay between 1 and 60 seconds for reconnecting individual motor loads. Provide relay contacts rated for motor-control circuit inrush and for actual seal currents to be encountered.

3. Programmed Neutral Switch Position: Switch operator with programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Adjustable pause from 0.5 to 30 seconds minimum, and factory set for 0.5 second unless otherwise indicated. Time delay occurs for both transfer directions. Disable pause unless both sources are live.

2.3 TRANSFER SWITCH ACCESSORIES

A. Remote Annunciator System:

1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches.
3. Annunciation panel display shall include the following indicators:

    a. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
    b. Switch position.
    c. Switch in test mode.
    d. Failure of communication link.

4. Annunciator Panel: LED-lamp type with audible signal and silencing switch.

    a. Indicating Lights: Grouped for each transfer switch monitored.
    b. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
    c. Mounting: Flush, modular, steel cabinet unless otherwise indicated.
    d. Lamp Test: Push-to-test or lamp-test switch on front panel.

B. Remote Annunciator and Control System:

1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Include the following functions for indicated transfer switches:

    a. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
    b. Indication of switch position.
    c. Indication of switch in test mode.
    d. Indication of failure of digital communication link.
    e. Key-switch or user-code access to control functions of panel.
    f. Control of switch-test initiation.
    g. Control of switch operation in either direction.
    h. Control of time-delay bypass for transfer to normal source.

3. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically shall revert to standalone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.
4. Remote Annunciation and Control Panel: Solid-state components. Include the following features:

    a. Controls and indicating lights grouped together for each transfer switch.

b. Label each indicating light control group. Indicate transfer switch it controls, location of switch, and load it serves.
c. Digital Communication Capability: Matched to that of transfer switches supervised.
d. Mounting: Flush, modular, steel cabinet unless otherwise indicated.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

B. Prepare test and inspection reports.

1. For each of the tests required by UL 1008, performed on representative devices, for all systems. Include results of test for the following conditions:

a. Overvoltage.
b. Undervoltage.
c. Loss of supply voltage.
d. Reduction of supply voltage.
e. Alternative supply voltage or frequency is at minimum acceptable values.
f. Temperature rise.
g. Dielectric voltage-withstand; before and after short-circuit test.
h. Overload.
i. Contact opening.
j. Endurance.
k. Short circuit.
l. Short-time current capability.
m. Receptacle withstand capability.
n. Insulating base and supports damage.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Floor-Mounting Switch: Anchor to floor by bolting.

1. Install transfer switches on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for seismic control devices specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
3. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
4. Provide workspace and clearances required by NFPA 70.

B. Annunciator and Control Panel Mounting: Flush in wall unless otherwise indicated.

C. Identify components according to Section 260553 "Identification for Electrical Systems."

D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

E. Comply with NECA 1.

F. Protection of Generators Start Circuit Control Conductors for ATS-4LS: Start circuit conductors must be kept entirely independent of all other wiring and be protected per NEC Articles 700.10(D)(4) and 700.10(D)(2).

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, motor controls, control, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.

1. Comply with requirements for raceways specified in Section 260533.13 "Conduits for Electrical Systems."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

F. Route and brace conductors according to manufacturer's written instructions and Section 260529 "Hangers and Supports for Electrical Systems." Do not obscure manufacturer's markings and labels.

G. Brace and support equipment according to Section 260548 "Vibration and Seismic Controls for Electrical Systems."

H. Final connections to equipment shall be made with liquidtight, flexible non-metallic conduit no more than 18 inches in length.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing equipment, test for compliance with requirements according to NETA ATS, except Section 4.
2. Perform inspections and tests listed in NETA ATS, Section 7.22.3.
3. Visual and Mechanical Inspection:

    a. Compare equipment nameplate data with Drawings and Specifications.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, grounding, and required clearances.
    d. Verify that the unit is clean.
    e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

f. Verify that manual transfer warnings are attached and visible.
g. Verify tightness of all control connections.
h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:

1) Use of low-resistance ohmmeter.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.

i. Perform manual transfer operation.
j. Verify positive mechanical interlocking between normal and alternate sources.
k. Perform visual and mechanical inspection of surge arresters.
l. Inspect control power transformers.

1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.

4. Electrical Tests:

a. Perform insulation-resistance tests on all control wiring with respect to ground.
b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.
c. Verify settings and operation of control devices.
d. Calibrate and set all relays and timers.
e. Verify phase rotation, phasing, and synchronized operation.
f. Perform automatic transfer tests.
g. Verify correct operation and timing of the following functions:

1) Normal source voltage-sensing and frequency-sensing relays.
2) Engine start sequence.
3) Time delay on transfer.
4) Alternative source voltage-sensing and frequency-sensing relays.
5) Automatic transfer operation.
6) Interlocks and limit switch function.
7) Time delay and retransfer on normal power restoration.
8) Engine cool-down and shutdown feature.
9) Generator start circuits integrity monitoring.

5. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

a. Check for electrical continuity of circuits and for short circuits.
b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
c. Verify that manual transfer warnings are properly placed.
d. Perform manual transfer operation.

6. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.

a. Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.
b. Simulate loss of phase-to-ground voltage for each phase of normal source.
c. Verify time-delay settings.
d. Verify pickup and dropout voltages by data readout or inspection of control settings.
e. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for one pole deviating by more than 50 percent from other poles.
f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

7. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

a. Verify grounding connections and locations and ratings of sensors.

B. Coordinate tests with tests of generator and run them concurrently.

C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

D. Transfer switches will be considered defective if they do not pass tests and inspections.

E. Remove and replace malfunctioning units and retest as specified above.

F. Prepare test and inspection reports.

G. Infrared Scanning: After Final Acceptance, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
3. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Final Acceptance.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.

B. Demonstrate operation of transfer switch in normal and emergency modes.

C. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.

D. Coordinate this training with that for generator equipment.

END OF SECTION 263600

SECTION 264313 - SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes field-mounted surge suppression devices (SPD) for low-voltage (120VAC to 480VAC) power distribution and control equipment:

1. Type 1 surge protective devices (SPDs).
2. Type 2 surge protective devices (SPDs).
3. Type 3, Type 4, and Type 5 surge protective devices (SPDs).
4. Enclosures.
5. Conductors and cables.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding of lighting control devices referenced by this Section.
3. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers and supports referenced by this Section.
4. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
5. Section 262413 "Switchboards" for integral SPDs installed by switchboard manufacturer.
6. Section 262726 "Wiring Devices" for integral SPDs installed by receptacle manufacturer.

1.2 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. I_n: Nominal discharge current.

C. Maximum Continuous Operating Voltage (MCOV): The maximum designated RMS value of the power frequency voltage that may be continuously applied to the mode of protection of an SPD.

D. Metal-Oxide Varistor (MOV): An electronic component with a significant bidirectional, nonlinear current-voltage characteristic.

E. Mode(s), Modes of Protection, or Protection Modes: Electrical paths where the SPD offers defense against transient overvoltages. Examples include: line to neutral (L-N), line to ground (L-G), line to line (L-L), and neutral to ground (N-G).

F. SCCR: Short-circuit current rating.

G. SVR: Suppressed voltage rating.

H. Type 1 SPDs: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service disconnect overcurrent device.

I. Type 2 SPDs: Permanently connected SPDs intended for installation on the load side of the service disconnect overcurrent device, including SPDs located at the branch panel.

J. Type 3 SPDs: Point of utilization SPDs.

K. Type 4 SPDs: Component SPDs, including discrete components, as well as assemblies.

L. Type 5 SPDs: Discrete component surge suppressors, such as MOVs that may be mounted on a printed wiring board, connected by its leads or provided within an enclosure with mounting means and wiring terminations.

M. Voltage Protection Rating (VPR): A rating selected from UL 1449 list of preferred values assigned to each mode of protection.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include electrical characteristics, specialties, and accessories for SPDs.
b. Certification of compliance with UL 1449 by qualified electrical testing laboratory recognized by authorities having jurisdiction including the following information:

1) Tested values for VPRs.
2) I_n ratings.
3) MCOV, type designations.
4) OCPD requirements.
5) Manufacturer's model number.
6) System voltage.
7) Modes of protection.

B. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's special warranty.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 article 285, by a testing agency, and marked for intended location and application.

C. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.

D. Comply with NEMA LS 1.

E. Comply with UL 1283 and UL 1449.

F. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Service Conditions: Rate SPD devices for continuous operation under the following conditions unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
2. Operating Temperature: 30 to 120 deg F.
3. Humidity: 0 to 85 percent, noncondensing.
4. Altitude: Less than 20,000 feet above sea level.

1.7 COORDINATION

Coordinate location of field-mounted SPD devices to allow adequate clearances for maintenance.

1.8 WARRANTY

A. Special Manufacturer Extended Warranty: Manufacturer warrants that SPDs perform in accordance with specified requirements and agrees to provide repair or replacement of SPDs that fail to perform as specified within extended warranty period.

1. Initial Extended Warranty Period: Ten (10) years from date of Final Acceptance Completion, for labor, materials, and equipment.
2. Follow-On Extended Warranty Period: Ten (10) years from date of Final Acceptance, for materials only, f.o.b. the nearest shipping point to Project site.

1.9 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Replaceable Protection Modules: One of each size and type installed.

PART 2 - PRODUCTS

2.1 TYPE 1 SURGE PROTECTIVE DEVICES (SPDs)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB, Electrification Business.
2. Current Technology Inc.; Danaher Power Solutions.
3. Eaton.

4. Schneider Electric USA, Inc.
5. Siemens Industry, Inc., Energy Management Division.

B. Source Limitations: Obtain devices from single source from single manufacturer.

C. Provide integral devices for switchboards and external devices elsewhere.

D. General Characteristics:

1. Reference Standards: UL 1449, Type 1.
2. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V and 120/240 V power systems, and not less than 115 percent of nominal system voltage for 480Y/277 V power systems.
3. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 320 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
4. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits must not exceed the following:

    a. Line to Neutral: 1200 V for 480Y/277 V.
    b. Line to Line: 2000 V for 480Y/277 V.

5. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits must not exceed the following:

    a. Line to Neutral: 700 V.
    b. Line to Line: 1200 V.

6. SCCR: Not less than 200 kA.
7. I_n Rating: 20 kA.

E. Options:

1. Include integral disconnect switch.
2. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Include indicator light display for protection status.
4. Include audible alarm.
5. Include NEMA ICS 5, dry Form C contacts rated at 5A and 250VAC, one normally open and one normally closed, for remote monitoring of protection status.
6. Include surge counter.

2.2 TYPE 2 SURGE PROTECTIVE DEVICES (SPDs)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB, Electrification Business.
2. Current Technology Inc.; Danaher Power Solutions.
3. Eaton.
4. Schneider Electric USA, Inc.
5. Siemens Industry, Inc., Energy Management Division.

B. Source Limitations: Obtain devices from single source from single manufacturer.

C. General Characteristics:

1. Reference Standards: UL 1449, Type 2.
2. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V and 120/240 V power systems, and not less than 115 percent of nominal system voltage for 480Y/277 V power systems.
3. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 200 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
4. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V and 208Y/120 V, three-phase, four-wire circuits must not exceed the following:
   a. Line to Neutral: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
   b. Line to Ground: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
   c. Neutral to Ground: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
   d. Line to Line: 2000 V for 480Y/277 V and 1200 V for 208Y/120 V.
5. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits must not exceed the following:
   a. Line to Neutral: 700 V.
   b. Line to Ground: 700 V.
   c. Neutral to Ground: 700 V.
   d. Line to Line: 1200 V.
6. SCCR: Equal or exceed 100 kA.
7. I_n Rating: 20 kA.

D. Options:

1. Include LED indicator lights for power and protection status.
2. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Include NEMA ICS 5, dry Form C contacts rated at 2 A and 24 V(ac) for remote monitoring of protection status.
4. Include surge counter.

2.3 ENCLOSURES

A. Indoor Enclosures: Type 4X.

B. Outdoor Enclosures: Type 4X.

2.4 CONDUCTORS AND CABLES

A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide OCPD and disconnect for installation of SPD in accordance with UL 1449 and manufacturer's instructions.

B. Install leads between disconnects and SPDs short, straight, twisted, and in accordance with manufacturer's instructions. Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

1. Do not splice and extend SPD leads unless specifically permitted by manufacturer.
2. Do not exceed manufacturer's recommended lead length.
3. Do not bond neutral and ground.

C. Use crimped connectors and splices only. Wire nuts are unacceptable.

3.2 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by Engineer.

B. Tests and Inspections:

1. Compare equipment nameplate data for compliance with Drawings and the Specifications.
2. Inspect anchorage, alignment, grounding, and clearances.
3. Verify that electrical wiring installation complies with manufacturer's installation requirements.

C. Nonconforming Work:

1. SPDs that do not pass tests and inspections will be considered defective.
2. Remove and replace defective units and retest.

D. Prepare test and inspection reports.

E. Manufacturer Services:

1. Engage factory-authorized service representative to support and supervise field tests and inspections.

3.3 STARTUP SERVICE

A. Complete startup checks in accordance with manufacturer's instructions.

B. Do not energize or connect electrical equipment to their sources until SPD devices are installed and connected.

C. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests; reconnect them immediately after the testing is over.

D. Energize SPDs after power system has been energized, stabilized, and tested.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to maintain SPD devices.

END OF SECTION 264313

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SECTION 265000 - LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Luminaires.
2. Luminaire fittings.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
2. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" specifies wiring connections installed by this Section.
3. Section 260529 "Hangers and Supports for Electrical Systems" specifies channel and angle supports installed by this Section.
4. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.
5. Section 260923 "Lighting Control Devices" specifies automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors installed by this Section.

C. References:

1. NEMA WD 6 - Wiring Devices-Dimensional Requirements.
2. NFPA 70 - National Electrical Code.
3. NFPA 101 - Life Safety Code.

1.2 DEFINITIONS

A. BUG Rating: Backlight, uplight, and glare rating for light pollution from exterior luminaires.

B. Correlated Color Temperature (CCT): The absolute temperature (in kelvins) of a blackbody whose chromaticity (color quality) most nearly resembles that of the light source.

C. Color Rendering Index (CRI): The measure of the degree of color shift objects undergo when illuminated by the light source as compared with the color of those same objects when illuminated by a reference light source. The lower the CRI of a light source, the more difficult it is to identify colors and stripes on electronic components and wiring.

D. IDA: International Dark-Sky Association.

E. IES: Illuminating Engineering Society.

F. LPD: Lighting power density.

1.3 ACTION SUBMITTALS

A. Submittals: Procedures for submittals. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: For each type of product.

A. Luminaires: Include the following additional information:

a. Product Certificates: Include product certificates stating compliance with standards listed below, signed by manufacturer or fabricator.

1) Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with current accreditation under National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.
2) Testing Agency Certified Data: For luminaires indicated on Lighting Fixture Schedule on the Drawings, photometric data certified by qualified independent testing laboratory. Photometric data for remaining luminaires must be certified by manufacturer.

b. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
c. Include operating characteristics, electrical characteristics, and furnished accessories.
d. Include schedule of submitted lighting products. Arrange schedule and accompanying product data in order by luminaire and lamp designations indicated on the Drawings.
e. Include battery and charger data for emergency lighting units.
f. Include ballast factor.
g. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
h. Include photometric data and adjustment factors obtained from qualified laboratory tests.
i. Include manufacturer's sample warranty language.

B. Luminaire Fittings: Include the following additional information:

a. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.
1) Listing criteria identified in approval letter must match specified listing criteria. Approval of only equipment's enclosure is not considered approval of equipment for intended application.
2) Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for similar products are not acceptable.

b. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
c. Include operating characteristics, electrical characteristics, and furnished accessories.
d. Include schedule of submitted lighting products. Arrange schedule and accompanying product data in order by luminaire and lamp designations indicated on the Drawings.
e. Include manufacturer's sample warranty language.

C. Shop Drawings: Prepare and submit the following:

A. Drawings, Diagrams, and Supporting Documents for Custom Luminaires:

a. Include plans, elevations, sections, and mounting and attachment details.
b. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
c. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' published instructions. Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

B. Field Reports:

A. Manufacturer's field reports for field quality-control support.
B. Manufacturer's field reports for system startup support.

1.5 CLOSEOUT SUBMITTALS

A. Submit manufacturer’s operation and maintenance instructions for each product.

B. Warranty documentation.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B. Luminaire Photometric Testing Laboratory: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" accredited under NIST HB 150-1, and complying with applicable IES testing standards.

C. Lighting Testing and Inspecting Agency: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience with testing and inspecting lighting installations in accordance with applicable IES standards.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect exposed surface finishes on lighting equipment by applying strippable, temporary protective covering before shipping.

1.8 WARRANTY FOR LUMINAIRES

A. Installer warrants that fabricated and installed luminaires perform in accordance with specified requirements and agrees to repair or replace products that fail to perform as specified within warranty period. Warranty must convey to Owner upon acceptance of the Work.

1.9 WARRANTY FOR BATTERIES

A. Manufacturer warrants that batteries perform in accordance with specified requirements and agrees to provide repair or replacement of batteries that fail to perform as specified within warranty period.

A. Initial Extended-Warranty Period for Li-ion Batteries: Five years from date of Final Acceptance; full coverage for materials only, freight prepaid.
B. Initial Extended-Warranty Period for Ni-Cd Batteries: Five years from date of Final Acceptance; full coverage for materials only, freight prepaid.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 LUMINAIRES

A. Surface-Mounted Luminaire:

A. Manufacturers: See Lighting Fixture Schedules.
B. Listing Criteria:
   a. LED Luminaires: UL CCN IFAM; including UL 1598.
   b. Outdoor Canopy Luminaires: UL CCN IFAW; including UL 1598.
   c. Marked in accordance with UL CCN HYXT, including UL 1598, for compatible power supply, installation location, and environmental conditions.

C. Furnish Products as scheduled. Refer to relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections for substitutions and product options.

1) All fixtures shall have a stock, or standard finish unless otherwise specified. Fixtures subject to corrosive or damp environments shall have corrosion resistant hardware and finishes.

B. Recessed Luminaire:
A. Manufacturers: See Lighting Fixture Schedules.
B. Source Limitations: Obtain products for this luminaire type from single manufacturer.
C. Listing Criteria:
   a. LED Luminaires: UL CCN IFAO; including UL 1598.
   b. Marked in accordance with UL CCN HYXT, including UL 1598, for compatible power supply, installation location, and environmental conditions.

D. Standard Features:

a. Ceiling Compatibility: NEMA LE 4.
b. Openings: Doors, frames, and access panels must operate smoothly, not leak light under operating conditions, and permit relamping without use of tools or parts falling from enclosure.

C. UL IFFR - Track-Lighting Systems:
A. Manufacturers: See Lighting Fixture Schedules.
B. Listing Criteria:

a. Track Lighting: UL CCN IFFR; including UL 1574.
b. Marked in accordance with UL CCN HYXT, including UL 1598, for compatible power supply, installation location, and environmental conditions.

2.3 LUMINAIRE FITTINGS

A. Luminaire Support Accessories:

A. Standard Features:

a. Sized and rated for luminaire weight.
b. Capable of maintaining luminaire position after cleaning and relamping.
c. Capable of supporting luminaire without causing deflection of ceiling or wall.
d. Capable of supporting horizontal force equal to 100 percent of luminaire weight and vertical force equal to 400 percent of luminaire weight.

B. Other Available Features Required by the Project:

a. Hook Hangers: Integrated assembly matched to luminaire, supply voltage, and equipment with threaded attachment, cord, and locking-type plug.
b. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gage wire supports.
c. Aircraft Cables: 5/32 inch diameter stainless steel aircraft cable supports.
d. Single-Stem Hangers: 1/2 inch nominal diameter steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
e. Rod Hangers: 3/16 inch nominal diameter, cadmium-plated, threaded steel rod.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Temporary Lighting: If approved by Architect, specified luminaires for the Project may be installed for temporary lighting. Install and energize minimum quantity of luminaires necessary to meet needs of construction activities. When construction is sufficiently complete, remove, disassemble, clean, and relamp luminaires used for temporary lighting before reinstalling for the Project's delivery.

3.3 INSTALLATION OF LIGHTING

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

A. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
B. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
C. Work in Confined Spaces: NFPA 350.
D. Installation of Indoor Lighting Systems: NECA NEIS 500.
E. Installation of Exterior Lighting Systems: NECA NEIS 501.
F. Installation of Luminaires, Lampholders, and Lamps: Article 410 of NFPA 70.
G. Installation of Emergency Lighting and Exit Signs: ICC IBC, NFPA 101, and Parts IV and V in Article 700 of NFPA 70.
H. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

A. Install luminaires level, plumb, and square with finished floor or grade unless otherwise indicated.
B. Install luminaires at height and aiming angle as indicated on the Drawings.
C. Coordinate layout and installation of luminaires with other construction.
D. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.
E. Exterior Bollard Luminaires:

a. Align units for optimum directional alignment of light distribution.
b. Install on concrete base with top 4 inch above finished grade or surface at luminaire location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

F. Exterior In-Ground Luminaires:

a. Install on concrete base with top 4 inch above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

G. Exterior Corrosion Prevention:

a. Do not use aluminum in contact with earth or concrete. When in direct contact with dissimilar metals, protect aluminum with insulating fittings or treatment.
b. When embedding steel conduits in concrete, wrap conduit with 10 mil thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

H. Flush-Mounted Luminaire Support:

a. Secured to outlet box.
b. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
c. Trim ring flush with finished surface.

I. Wall-Mounted Luminaire Support: Attached to structural members in walls.

a. Do not attach luminaires directly to gypsum board.

J. Suspended Luminaire Support:

a. Ceiling Mount: As specified.

b. Pendants and Rods: Where longer than 48 inch, brace to limit swinging.
c. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
d. Continuous Rows of Luminaires: Provide tubing or stem for wiring at one point and tubing, rod or wire support for suspension for each unit length of luminaire chassis, including one at each end.
e. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

K. Ceiling-Grid-Mounted Luminaire Support:

a. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each luminaire. Locate not more than 6 inch from luminaire corners.
b. Support Clips: Fasten to luminaires and to ceiling grid members at or near each luminaire corner with clips that are UL listed for application.
c. Luminaires of Sizes Smaller than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support luminaires independently with no fewer than two 3/4 inch metal channels spanning and secured to ceiling tees.
d. Seismic Restraint: Install at least one independent support rod or wire from structure to tab on luminaire. Wire or rod must have breaking strength for luminaire weight with safety factor of 3.0.

L. Remote Mounting of Ballasts or Drivers: Do not exceed distance between ballast or driver and luminaire recommended by ballast or driver manufacturer.
M. Install wiring connections for luminaires.
N. Identification: Provide labels for luminaires and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.
b. Provide warning signs.
c. Label each enclosure with engraved metal or laminated-plastic nameplate.

D. Interfaces with Other Work:

A. Coordinate installation of new products for with existing conditions.

E. Systems Integration: Integrate lighting control devices and equipment with electrical power connections for operation of luminaires as specified.

3.4 FIELD QUALITY CONTROL OF LIGHTING

A. Administrant for Electrical Power Tests and Inspections:

A. Quality Assurance: Field inspection, testing and adjusting shall be as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.
B. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
C. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
D. Administer and perform tests and inspections.

B. Administrant for Field Tests and Inspections of Lighting Installations:
A. Administer and perform tests and inspections.

C. Tests and Inspections:

A. Perform manufacturer's recommended tests and inspections.
B. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
C. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
D. Verify operation of photoelectric controls.
E. Exterior Illumination Tests:

a. Measure light intensities at night. Use photometers with calibration referenced to NIST standards.

D. Nonconforming Work:

A. Luminaire will be considered defective if it does not pass tests and inspections.
B. Remove and replace defective units and retest.

E. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services: Engage factory-authorized service representative to support field tests and inspections.

A. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project's site.

3.5 SYSTEM STARTUP

A. Perform startup service.

A. Complete installation and startup checks in accordance with manufacturer's published instructions.
B. Burn-in lamps that require specific aging period to operate properly, prior to occupancy by Owner.
C. Charge batteries minimum of 24 hours and conduct one-hour discharge test.

3.6 ADJUSTING

A. Luminaire Aiming Adjustments: Provide on-site assistance in adjusting aiming direction of luminaires to suit occupied conditions. Make up to two visits to the Project's site during other-than-normal hours for this purpose. Some of the Work may be required during hours of darkness.

A. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
B. Parts and supplies must be manufacturer's authorized replacement parts and supplies.
C. Adjust aim of luminaires in presence of Architect.

3.7 CLOSEOUT ACTIVITIES

A. Contract Closeout: Demonstrate installed work as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Training:

A. Train Owner's maintenance personnel on the following topics:

a. How to adjust, operate, and maintain luminaires and photoelectric control

3.8 PROTECTION

A. After installation, protect lighting equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

B. Relamp luminaires that have failed lamps at Substantial Completion. Replace LED modules in which more than 5% of the LEDs have failed lamps at Final Acceptance of the Work.

END OF SECTION 265000

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SECTION 265100 – ARCHITECTURAL INTERIOR LIGHT FIXTURES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide and install lighting fixtures as shown on drawings, and supplemental documents provided by the Architect/Designer, and herein specified.

1.2 RELATED SECTIONS

A. Section 260943 - Architectural Lighting Controls Specifications

1.3 DEFINITIONS

A. The term Architect refers to the Architect, Lighting Designer or Owner's Representative individually or collectively.

B. The term Contractor refers to the bidding party of this document.

1.4 GENERAL REQUIREMENTS

A. Fixture and equipment supplier will provide an ITEMIZED Bill of Materials with each fixture or control system component listed as a line item. Lot pricing is not acceptable.

B. Provide all lighting fixtures as shown complete with all lamps, completely wired, controlled and securely attached to supports.

C. Where a catalog number and a narrative or pictorial descriptions are provided, the written description shall take precedence and prevail.

D. General Contractor shall provide electrical subcontractor with entire lighting specification (including fixture illustrations and sketches and cut sheets); electrical subcontractor shall provide each specified manufacturer with complete information about the fixtures they will supply.

E. Type of fixtures shall be as indicated alphanumerically and as specified.

F. Fixture details shown may be modified by the manufacturer provided all the following conditions have been met:

1. Fixture performance is equal or improved;
2. Structural, mechanical, electrical, safety, and maintenance characteristics are equal or improved;
3. Cost to the Owner is reduced or equal.
4. Modifications have been reviewed by the Architect and have been approved by the Architect in writing.

1.5 STANDARDS

A. The standards and regulating committees referred to in this specification and to which compliance with is required are:

1. UL Underwriters Laboratories
2. NEC National Electric Code
3. ANSI American National Standards Institute
4. ASTM American Society of Testing and Materials
5. NEMA National Electrical Manufacturers Association
6. CBM Certified Ballast Manufacturers

B. All fixtures and assembled components shall be new, of good quality, and be approved by and bear the label of UL or other approved testing agencies, i.e. CSA, ETL, unless otherwise specified in writing.

C. All fixtures shall meet all required local, state and/or national building, electrical and energy codes and regulations.

D. Fixtures installed outdoors in areas exposed directly to weather shall be UL listed for wet locations.

E. Fixtures installed in outdoor protected areas (such as building soffits) and indoors in areas subject to water or extreme humidity shall be UL listed for damp locations.

F. Fixtures installed in close proximity to saltwater environments such as an aquarium animal enclosure with high humidity and high salinity, whether indoors or outdoors, shall be UL listed for wet locations, rated a minimum of IP65, and shall be made of marine-grade materials or sealed with a corrosion resistant coating.

1. All power and data connections to these fixtures shall be rated a minimum of IP65 rated and waterproof.

1.6 BIDDING

A. Follow bidding procedures as described in General Conditions Section of this specification.

B. Provide unit and alternate prices if required in Fixture Description part of this specification section.

1.7 SUBSTITUTIONS

A. Bidders' attention is called to the following procedure to be followed in submitting alternate fixture manufacturers than those specified:

1. Bidders wishing to obtain approval on brands other than those specified by name and catalog number in Section 2.2, LIGHTING FIXTURE DESCRIPTIONS, shall submit their requests not later than ten (10) business days before the bid opening. Approval will be in the form of an addendum to the specifications issued to all prospective bidders indicating that the additional brand or brands are approved as equal to those specified as far as the requirements of the project are concerned. If the bidders do not elect to obtain prior approval during the time so specified, the Owner has no obligation to review or consider any such article after the contract award.

2. If the bidder wishes to substitute fixtures from alternate manufacturers, their attention is called to Section 2.1, GENERAL REQUIREMENTS of PART 2 - PRODUCTS. In addition, they shall note that the dimensions of visible parts of many fixtures (for example, the aperture diameters of incandescent fixtures) are binding to the bidder and cannot be changed without prior approval by the Architect.
3. Request for approval shall be accompanied by working fixture samples (with an appropriate lamp, complete photometry, mechanical and electrical data, list of materials and finishes and unit cost to the Owner) of both the specified brand and the proposed substitutes as required to make complete comparison and evaluation. These samples shall be in addition to those required by Lighting Fixture Specification. The above data shall be delivered separately to the Architect and the Lighting Designer. The fixture samples shall be furnished and installed, at the bidder's expense, at the location selected by the Architect. In addition, the bidder shall furnish the Architect and the Lighting Designer with the name and location of at least one completed project where each proposed substitute has been in operation for a period of at least six (6) months, as well as the names and addresses of the Owner, the Lighting Designer and the Architect of record.

1.8 SUBMITTALS FOR REVIEW

A. For standard catalog items with no modifications, submit catalog cut sheets prepared by the manufacturer which clearly show all elements to be supplied and all corresponding product data (including dimensions; ratings; performance data; lamping; driver manufacturer and model number; voltage; accessories or options and any miscellaneous items detailed in the written description of the specification). If cut sheet shows more than one (1) fixture type, all non-applicable information shall be crossed out.

B. For standard cataloged fixtures:

1. Submit one sample cone for each fixture type for review. Submit a certificate of compliance with Alzak or equal finish requirements with all requests for approval.
2. When more than one louver panel occurs in a fixture, submit as a part of shop drawings the dimensioned layout of individual louver panels and supporting "tee" members.

C. For custom fixtures, modified fixtures, or linear LED fixtures mounted in continuous rows, submit a reproducible drawing prepared by the manufacturer showing all details of construction, lengths of runs, lamping layout, pendant locations, power locations, finishes and list of materials. Drawings must be to scale. Contractor shall provide manufacturer with field dimensions where required. If scallop shields, wall wash reflectors, or baffles are required, drawings shall indicate relative position to wall or adjacent vertical surface.

D. For all submittals under paragraphs A through C above, manufacturer shall provide submittals within two weeks of receipt of order. All submittals shall have project name and fixture type clearly shown.

E. Fixture cuts and shop drawings shall follow the procedures, and be submitted in quantities and format, as described in the General and Supplemental General Conditions and Division 1 Specifications Sections.

F. Submittal information must include IES and Photometric files with the fixture specifications.

G. The Architect shall make the final determination as to whether or not the submittal contains sufficient information and reserves the right to request a shop drawing if the fixture cut is insufficient.

H. Mock-Ups

1. It shall be the responsibility of the Contractor to provide a mock-up of the lighting fixture or lighting systems as indicated in the fixture description. The mock-up shall be erected within a time period and in a location that is acceptable to the Architect.
2. The mock-up installation shall closely conform to the conditions of the actual installation as to: height, distance from ceiling, number and type of lamps, material, color and etc. The Contractor shall submit a written description of each proposed mock-up with drawings in order to obtain the Architect's approval prior to commencement of each mock-up.
3. The purpose of the mock-up will be to study the general appearance and performance of the intended lighting systems. At that time, certain minimal test variations may be requested as to lamp location, lamp type, reflector shape, color and etc. Final modifications, if any, shall be considered a part of these Specifications and shall be accomplished with no additional cost to the Owner.

I. Samples

1. It shall be the responsibility of the Contractor to provide a sample(s) fixture as indicated in Section 2.2, LIGHTING FIXTURE DESCRIPTIONS. When samples are called for the manufacturer shall provide two working samples complete with lamp, ballast or power supply (rated for 120-Volt operation) and 6' pigtail with 3-prong Edison plug.
2. The sample(s) shall be shipped to a location that is determined by the Architect. Shipping and return shipping costs shall be provided as part of the contract.
3. The purpose of the sample is to review manufacturing techniques, detailing, lamping and scale. Sample fixtures must be approved prior to fabrication of fixtures for the project. Minor modifications, if any shall be considered part of these Specifications and shall be accomplished with no additional cost to the Owner.
4. Sample fixtures may not be used on the project.

1.9 SUBMITTALS FOR INFORMATION

A. Submittals for information shall follow the procedures, and be submitted in quantities and format, as described in the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Submit manufacturer’s installation instructions. Indicate application conditions and limitations of use. If applicable, indicate limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.10 QUALITY ASSURANCE

A. Installer Qualifications: Installer shall be one who is experienced in performing the work of this section, and who has specialized in installation of work similar to that required for this project.

B. Manufacturer; Company specializing in manufacturing the Products specified in this section with minimum three years document experience.

C. Site Acceptance Testing:

1. Contractor to inspect, test, and document all luminaires to be in full working order upon installation and prior to handover to the Owner. The SAT document should include the following data points:

a. Fixture type code (from Contract drawings)
b. Fixture manufacturer
c. Fixture name and manufacturer order code
d. Fixture unit number (from Contract drawings)
e. Fixture DMX address (if applicable)

1.11 WARRANTIES

A. All fixtures and workmanship shall be guaranteed free of defects and fully operational for a minimum of one year after the acceptance of the project by the Owner. Any fixtures or workmanship found to be defective during the warranty period will be either fixed or replaced by the Contractor at no cost to the owner.

B. Drivers/power supplies for LED fixtures shall be covered by three-year warranty against defects in workmanship or material. Warranty shall include in-warranty service program providing for payment of authorized labor charges incurred in replacement of inoperative, in-warrantee drivers/power supplies.

1.12 EXTRA PRODUCTS

A. Furnish one replacement lighting fixture of each type. Furnish one replacement lighting fixture for each 24 of each type, but no less than one.

B. Furnish one replacement LED lighting module for each type. Furnish one replacement LED lighting module for each 24 of each module type, but no less than one.

C. Furnish one replacement lighting driver/power supply type for each 24 of each type, but no less than one.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Furnish products as scheduled.

B. All lighting fixtures shall be approved by third party testing agencies and shall bear their label.

C. All fixtures shall have a stock or standard finish unless otherwise specified. Fixtures subject to corrosive or damp environments shall have corrosion resistant hardware and finishes.

D. All fixtures shall be installed complete with lamps or LED sources as specified.

E. Lighting fixture types shall be furnished as required in Section 2.2, LIGHTING FIXTURE DESCRIPTIONS. Catalog numbers are provided as a guide to the design and quality of the fixture desired. Equivalent designs and equal quality fixtures of other manufacturers listed will be acceptable upon approval of the Architect/Designer. The Contractor shall verify from the contract drawings the type ceilings or walls the fixture is to be used with and shall provide compatible mounting attachments and trim. Provide all accessories or additional materials required to maintain the ceiling fire rating as required by regulatory authorities.

F. Ferrous mounting hardware and accessories shall be finished using either a galvanic or phosphate primer/baked paint process to prevent corrosion and discoloration of adjacent materials.

G. For weatherproof and vapor tight fixture installation painted finishes of fixtures and accessories shall be weatherproof enamel using proper primers or hot dipped galvanized and bonderized epoxy. In accordance with manufacturer's requirements. Unless otherwise specified all painted surfaces shall have a life expectancy of not less than twenty years.

1. Hangers shall be conduit with chemically resistant, weatherproof, baked enamel finish.
2. Where aluminum parts come in contact with bronze parts, apply to both surfaces a coating material to prevent corrosion.
3. Where aluminum parts come in contact with bronze parts, apply to both surfaces a coating material to prevent corrosion.

H. Fasteners shall be manufactured of non-magnetic stainless steel or anodized aluminum, except in indoor applications where galvanized steel shall be acceptable.

I. Fixtures shall be free of light leaks and shall be designed to provide sufficient ventilation of lamps and ballasts including vent holes where required.

J. Outdoor fixtures shall have wire mesh corrosion resistant screens in the vent holes.

K. All control, data, and DMX512 connections in areas exposed to weather shall be watertight and have protected waterproof connections. DMX plug boxes shall have waterproof covers that are effective when a port is occupied or empty.

L. All sheet metal work shall be free from tool marks and dents and shall have accurate angles bent as sharp as compatible with the gauges of the required metal. All intersections and joints shall be formed true and of adequate strength and structural rigidity to prevent any distortion after assembly. All sheet metal shall be free of light leaks. All edges shall be finished in order that there are no sharp edges exposed. All miters shall be in accurate alignment with abutting intersecting members. Piecing of plates in individual runs in single planes and the use of spliced pieces or filler material to cover defective workmanship shall not be acceptable. Sheet metal work shall be properly fabricated in order that planes will not deform (i.e. become concave or convex, due to normal expected ambient and operating conditions).

M. Lampholders shall hold lamps securely against normal vibrations and maintenance handling. Provide solid nickel or nickel-and-silver-plated contacts in lampholders for following types of lamps:

1. Mogul screw base incandescent.
2. Lamps in outdoor fixtures.
3. Tungsten-halogen lamps.
4. Screw-in or twist-in LED lamps

N. Wiring channels and lampholder mountings shall be rigid and accurately made.

O. Reflector Cones:

1. Provide 45-degree lamp and lamp image cut-off unless otherwise specified. In fixtures where upper reflector is separate from cone, cut-off shall be 45 degrees unless otherwise specified.
2. Plastic materials shall not be used for reflector cones or aperture plates unless otherwise noted in Section 2.2 Lighting Fixture Descriptions.

3. Fixtures in which reflector cones are riveted or welded to housing or where removal of cone requires pressure to be applied to finished surface of reflector shall not be acceptable.
4. Cone flange shall be formed as an integral part of the cone and shall have identical color and finish as the cone, except as shown. The flange major surface shall be perpendicular to the cone axis. The width of the flange shall adequately cover the ceiling opening without light leaks. No fixture parts (housing, mounting frame, etc.) shall be visible between the ceiling surface and the edge of the cone flange. The same requirement shall be applicable to fixtures where main reflector extends down to the bottom edge of the fixture without a separate cone. In such case, the flange shall be formed as an integral part of the main reflector.
5. Reflector cones shall be manufactured of uniform gauge, not less than 0.032" thick, high purity aluminum Alcoa 3002 alloy free of spin marks or other defects or blemishes caused during manufacturing unless otherwise noted in Section 2.2 Fixture Descriptions.
6. The finish of the inner surface of the reflector shall be highly specular as produced under the Alzak or equal process. The reflector shall have an anodic coating of not less than four mils thick. The reflector inner surface shall be free of water spotting and shall maintain a reflectivity ratio of not less than 83% on clear specular finish. The reflector shall have a low iridescence finish free from multiple colors seen from normal viewing angles. Colors shall be derived from dyes supplied by Sandoz Chemical Company or approved equal.
7. The reflecting surface of the cone shall be tested for proper sealing. Test per ASTM B136-63T.
8. Fixtures with Alzak reflector cones, unless otherwise specified, must be furnished by the same manufacturer.
9. Reflector cone retention devices shall not deform cone in any manner whatsoever.
10. Submit a certificate of compliance with Alzak finish requirements with all requests for approval.

P. Lenses:

1. Fresnel:

a. Lens shall have uniform brightness throughout the entire visible area at angles from 45 degrees to 90 degrees from vertical, without bright spots or striations.
b. Lens shall have opaque risers; color shall be as specified in Section 2.2, LIGHTING FIXTURE DESCRIPTIONS.
c. Finish of visible regress surface of door shall be matte baked enamel paint, special color as selected by Architect.
d. All fixtures with Fresnel lenses, unless otherwise specified, must be furnished by the same manufacturer.

2. Glass:

a. Flat glass lenses shall be heat tempered borosilicate glass unless otherwise noted.
b. Glass finishes, i.e. sandblasting, etching, polishing shall be performed as described in the fixture description.

3. Acrylic:

a. Lenses shall be of injection molded crystal clear material 100% virgin acrylic (except as shown). For lenses with male pattern of pyramids or cones, specified minimum thickness refers to distance from flat surface to base of pyramids (cones), or thickness of undisturbed material. For lenses with female pattern, specified minimum thickness refers to overall thickness of material.
b. Lenses shall fully eliminate lamp images when viewed from all directions within the 45 degrees to 90 degrees angle from vertical when the ratio of lamp spacing to the distance from the lamp underside to the top of the lens does not exceed 1.50. Within

the viewing angle from 0 degrees to 45 degrees the ratio of the maximum brightness (under a lamp) to minimum brightness (between lamps) shall not exceed 3 to 1.

c. Finished, i.e. sandblasting, etching, polishing shall be performed as described in the fixture description.

Q. Louvers:

1. Parabolic:

a. Lens shall have uniform brightness throughout the entire visible area at angles from 45 degrees to 90 degrees from vertical, without bright spots or striations.
b. Lens shall have opaque risers; color shall be as specified in Section 2.2, LIGHTING FIXTURE DESCRIPTIONS.
c. The finish of the inner surface of the reflector shall be semi specular as produced under the Alzak process. The reflector shall have an anodic coating of not less than four mils thick. The reflector inner surface shall be free of water spotting and shall maintain a reflectivity ratio of not less than 83% on clear specular finish. The reflector shall have a low iridescence finish free from multiple colors seen from normal viewing angles.

2. Flat Blade:

a. Provide flat blade louvers within formed frame, finish and color as specified.
b. Louvers to provide minimum of 45 degree cut-off from lamp image.
c. Blade thickness to minimum .125” flat steel.

R. In adjustable fixtures, aiming and positive locking devices shall be provided.

S. Fixtures with an adjustable lamp and using a lamp with an asymmetrical light pattern shall have an aiming stop which can be permanently set so that the lamp shall remain correctly positioned after service or re-lamping.

T. Incandescent Fixtures:

1. Incandescent fixtures, unless otherwise specified, shall be operated at 90% of rated lamp voltage by means of a bucking transformer at the distribution panel for extended lamp life. Bucking transformers shall not be used on those circuits where dimmers are used. Refer to Electrical Engineers drawings and Specifications for manufacturer, quantity and size of bucking transformers required. (Refer to Section 2.2 Lighting Fixture Descriptions, for lamp voltages.)

2. Housing:

a. Steel, bonderized or equal rust protected or aluminum, rigid construction. Minimum gauge thickness shall be as follows:
   1) Interior locations: No.20 gauge steel, No. 16 gauge aluminum.
   2) Exterior locations: No.18 gauge steel, No.14 gauge aluminum.
b. Finish: Baked enamel finish (except when otherwise specified).
   1) Concealed interior surfaces (this applies to interior hardware, lampholders, yokes, brackets, etc.): matte black.
   2) Concealed exterior surfaces: matte black.
   3) Visible surfaces: color and texture as specified below for each fixture type or as selected.
   4) Exterior fixture finish: refer to "Exterior Fixture Finishes" above.

c. Reflector Cones: refer to "Reflector Cones", above.
d. Reflectors not visible within normal viewing angles shall be highly specular as produced under the Alzak process, except when otherwise specified. Minimum reflectance shall be 83%.
e. Provide safety devices for removable fixture elements (cones, reflectors, lenses and fixture doors, etc.). Safety devices shall support removable elements when not in normal operating position, and be detachable if necessary. This device shall not interfere with fixture performance, maintenance, or the seating of any fixture element, and shall not be visible during normal fixture operation.
f. Thermal protection device shall be provided as required by code.

U. LED Lighting Systems/Fixtures

1. The Contractor shall furnish the complete LED-based lighting system as described in the architectural drawings.
2. The color temperature in all lamps of the same type shall be consistent and remain so over the life of the lamp. The Contractor shall replace lamps/fixtures exhibiting inconsistent lamp color. The color or color temperature of replacement LED lamps shall match those of the same lamp types that remain in operation.
3. The minimum color rendering index of white LEDs shall be 80.
4. Electrical and photometric performance of LED assemblies and luminaires shall conform to IES LM 79-08.
5. Minimum lumen maintenance shall be 70% of the rated initial lumen output at 50,000 hours of operation. Measurement of lumen maintenance shall be in accordance with IES LM-80-08.
6. The LED fixture shall be operated at constant and carefully regulated current levels. LEDs shall not be overdriven beyond their specified nominal voltage and current.
7. LED fixture housing shall be designed to transfer heat from the LED board to the outside environment.
8. All LEDs used in the LED fixture shall be high brightness and proven quality from established and reputable LED manufacturers.
9. Manufacturer of LED systems shall utilize an advanced production LED binning process to maintain color consistency.
10. LED fixture shall be UL listed or UL classified.
11. LED fixture shall be CE certified.
12. All LED fixtures and power/data supplies for any given system shall be provided by a single manufacturer to ensure compatibility.
13. All products associated with installation and control of the LED system, including peripheral devices and software are to be provided by a single manufacturer for any given system.
14. LED Drivers and Power/data supplies:

    a. Outputs shall have current limiting protection.
    b. Shall provide mis-wiring protection.
    c. Shall have power factor correction.
    d. Power factor ≥ 90%
    e. Efficiency ≥ 90%
    f. Current crest factor – 1.5 minimum.
    g. Total harmonic distortion < 20%
    h. Rated life – 50,000 hours
    i. For indoor and building mounted fixtures, provide minimum 2kv surge suppression integral with the driver (5kv preferred if available).
    j. For outdoor fixtures, provide minimum of 10kv surge suppression integral with the driver.

15. Manufacturer shall be able to provide supporting documentation of the product meeting third party regulatory compliance.

16. Manufacturer shall ensure that products undergo and successfully meet appropriate design and manufacturability testing including Design FMEA, Process FMEA, Environmental Engineering Considerations and Laboratory Tests, IEC standards and UL/CE testing.
17. All LED fixtures (100% of each lot) shall undergo a minimum eight-hour burn-in test during manufacturing.
18. Manufacturer shall provide optical performance, polar diagrams, and relevant luminance and illuminance photometric data based on test results from an independent testing lab.
19. Manufacturer shall provide photometric data in IES file format in accordance with IES LM-63-2002, based on test results from an independent testing lab.
20. Manufacturer shall provide mechanical, electrical, network communication and environmental specifications.
21. Manufacturer shall provide installation guides.
22. Manufacturer shall provide system wiring diagrams.
23. Manufacturer shall provide applications engineering services.
24. Manufacturer shall provide the option of a factory-trained applications engineer for onsite supervision of startup and/or programming.
25. Manufacturer shall have at least five years of experience designing, selling and supporting intelligent LED systems.
26. Manufacturer shall warrantee that LEDs shall not change their visible color output frequency by more than 2 MacAdam Ellipses on the CIE Chromaticity Chart for a period of 3 years. The requirement is that the diode shall maintain color consistency over life. For example, red diodes shall remain within the closest 2 MacAdam Ellipses, blue diodes shall remain within the closest 2 MacAdam Ellipses, white diodes shall remain within the closest 2 MacAdam Ellipses, etc. Red green blue fixtures obviously produce color changing light, however the individual diode's output color must remain consistent over life.

V. Wiring

1. Voltage Rating

    a. For voltages up to 120 volts fixture wiring shall be rated for 300 volts minimum.
    b. For voltages above 120 volts fixture wiring shall be rated for 600 volts minimum.

2. Temperature Rating - Internal to Fixture

    a. All wiring shall be code-approved for fixture wiring, and shall comply with the following temperature ratings unless fixture design or local codes require higher temperature wire.
    b. Incandescent

        1) Minimum rated between lampholder(s) and separately mounted junction box or internal transformer.
        2) Minimum rated between internal transformer and separately mounted junction box.
        3) Tungsten-halogen lamp seal temperature shall not exceed 350oC at ambient of 25oC when tested per UL Bulletin 57, Par. 328-334. Submit certified heat test data by independent testing laboratory.

3. Temperature Rating – External to Fixture

    a. All flexible cord wiring between fixture components or to electrical receptacle and not in wireways shall have a minimum temperature rating of 105 Degrees C.
    b. Cord type shall be suitable for application and shall be fitted with proper strain relief and watertight entries where required by application.

4. Splices

a. Splices internal to fixture shall be made within separate splice compartments and shall utilize nylon insulation crimped connections or insulated quick disconnects
b. Splices to branch circuit wiring in separate junction boxes shall utilize flame retardant thermoplastic caps with fully seated helical metal spring and threaded entry.

5. No internal wiring shall be visible at normal viewing angles, i.e., above 45 Degrees from vertical. Use additional wire clamps if necessary. Anticipate increased visibility if fixtures are mounted on or recessed within a sloping surface
6. Any fixture fed from more than one panel, i.e., for normal and night or emergency operation, shall have separate neutrals to each panel.
7. No Common Neutrals shall be permitted in dimmed loads or circuits.
8. Furnish code-approved wiring ion ceiling cavities forming air plenums.

W. Lamps:

1. Incandescent lamps:

a. 120 volt, except as shown. Refer to Section 2.2, LIGHTING FIXTURE DESCRIPTIONS for details.

b. All lamps, except as specified, shall be of the same manufacturer:

1) General Electric
2) North American Philips
3) Osram/Sylvania

c. Energy saving type lamps which use an electronic diode shall not be used unless otherwise specified in Section 2.2, LIGHTING FIXTURE DESCRIPTIONS.

2. High intensity discharge lamps: Refer to Section 2.2, LIGHTING FIXTURE DESCRIPTIONS for details. All lamps, except as specified, shall be of the same manufacturer:

1) General Electric
2) North American Philips
3) Osram/Sylvania
4) Venture

2.2 LIGHTING FIXTURE DESCRIPTIONS

A. Refer to Lighting Drawings sheet LT-003 Light Fixture Schedule for 3-Spec Lighting Fixture and Controls Specifications.

B. Electrical contractor shall provide a cost estimate for the lighting installation that itemizes equipment and labor costs.

C. LED phase dimming driver type, linear or logarithmic, to be determined by Control system device phase dimming curve or output.

PART 3 - EXECUTION

3.1 EXECUTION

A. Provide labor, installation supervision, materials and equipment required for the complete installation of the project including lighting system components described in the project drawings and specifications.

B. No Common Neutrals shall be permitted in dimmed loads or circuits.

C. All fixtures to have 3 copper wires supplied and installed for power and dimming control. Line Voltage Power – White (Neutral), Black (Hot), Green (Ground).

D. All DMX-controllable fixtures to have 3 copper wires supplied and installed for DMX data. Data positive, Data negative, Ground/Shield. The colors for these wires must be consistent across the project.

E. Contractor to provide all Material Handling and Lift Equipment.

F. The Contractor shall be obligated to review all construction documents for their accuracy and feasibility and shall provide any concerns and comments in writing to Architect. Include Items, which are not specifically shown, described or detailed which are required to provide a complete, functional and operational system.

G. The Architect shall not be held responsible for the omission or absence of any detail, construction feature, etc., which may be required in the production of the fixtures. The responsibility of accurately fabricating the fixtures to the fulfillment of this specification rests with the Contractor.

H. All fixtures have been specified in the absence of accurate building details. Please confirm all mounting methods and details with the Architect and Fixture Manufacturers.

I. Provide accessories as required for ceiling construction type indicated on Architect's Finish Schedule. Fixture catalog numbers do not necessarily denote specific mounting accessories for type of ceiling in which a fixture may be installed.

J. Provide adequate and sturdy support for each lighting fixture. Contractor shall be responsible for verifying weight and mounting method of all fixtures and furnish and install suitable supports. Fixture mounting assemblies shall comply with all local seismic codes and regulations.

K. All bracket and suspension systems will be installed as intended by the manufacturer. Brackets and suspension systems will be specified that are rated for the weight of the entire assembly and shall meet minimum safety factor requirements (safety factor of five (5)).

L. All suspended devices will be attached to the facility with grade 5 hardware or better.

M. Separate safety cable assemblies or other independent load path will be provided. The safeties will attach directly to the suspended device and structural facility member. The safety assemblies will be rated for a minimum safety factor of five (5). All fixtures must have dual redundant safety cable tie offs on the fixture and any loose parts (i.e. color frames, accessories, etc.) and not allow a single point of failure.

N. The Contractor shall be responsible for checking the ceiling finishes in all areas where recessed fixtures are being installed to ensure that the fixtures ordered for these areas are purchased with suitable ceiling trim for the ceiling finish. Fixtures which are delivered to the site with wrong ceiling

trim or flanges shall be replaced with the correct trims at no additional cost to the Owner. The Contractor shall notify the consultant if the ceilings are improperly installed and shall be guided by his decisions before proceeding with the fixture installation.

O. If lighting fixtures penetrate a fire rated ceiling, they shall be enclosed with suitable fire rated enclosure above the ceiling having the same fire rating as the ceiling. The Contractor for Division 26 shall carefully check the architectural documents for ceiling details and shall ensure the fire rated enclosures are provided to maintain integrity.

P. Install rows of fixtures accurately on straight lines unless otherwise indicated on drawings. Coordinate with mechanical work.

Q. Install fixtures with vent holes free of air blocking obstacles.

R. Where plaster ceilings occur, furnish plaster frames for setting under other applicable sections. Direct the setting and be responsible for correct location: make sure the bottom of frame is flush with finished ceiling, forming screed edge for finished plaster.

1. Fixtures shall be supported by plaster frames utilizing yokes or leveling lugs.

    a. Fixtures and support elements shall not be mounted to or in contact with ducts or pipes.
    b. Yokes shall have channel cross section of sufficient gauge, and shall support a fixture by means of not fewer than two (2) bolts each.

2. If air diffusers are located in common continuous rows with lighting fixtures in plaster ceilings, furnish plaster frames of proper length to accommodate diffusers.

S. Lighting fixtures recessed in ceilings which have a fire resistive rating of one hour or more shall be enclosed in a box which has a resistive rating equal to that of the ceiling.

T. Contractor shall be responsible for adjusting aperture rings on all ceiling recessed fixtures to accommodate various ceiling material thickness. Contractor shall be responsible for coordinating the cut-out size in ceiling to ensure aperture covers cut-out entirely. The bottom of aperture rings shall be flush with finished ceiling or not more that 1/16" above. Under no circumstances will the aperture ring extend below the finished ceiling surface.

U. For fixtures with variable position lamp holder assemblies Contractor shall confirm prior to installation proper lamp holder (socket) position in field, and shall adjust, if necessary, after coordination with manufacturer.

V. Surface Mounted Fixtures: Support surface mounted fixtures from structural members other than ceiling tees.

W. Focusable Fixtures: Fixtures whose design-intent it is to adjust the tilt and/or pan of the fixture shall not be installed in a manner that restricts movement of the fixture and the ability of the Designer to focus the fixtures.

1. Focusable Fixtures whose yokes rotate on a single central bolt shall not have a secondary bolt through or adjacent to the yoke that restricts movement of the fixture.
2. Focusable Fixtures that require safety cables shall have safety cables installed with enough length so as not to restrict the ability to rotate the fixture 180-degrees or tilt the fixture from 0- to 90-degrees.
3. Focusable Fixtures must be installed with enough power and/or data cable slack so as not to restrict the ability to rotate the fixture 360-degrees or tilt the fixture from 0- to 90-degrees.

X. Pendant Mounted Fixtures:

1. Pendant mounted fixtures shall be supported from structural framework of ceiling or from inserts cast into slab.
2. All pendants shall have swivel aligners located at the top ends; pendants shall be 1/2" rigid steel conduit unless specifically indicated otherwise on drawings or in specifications.
3. All pendant and surface mounted fixtures shall be supported with two (2) supports per four foot section or three (3) per eight foot section.

Y. Bracket Mounted Fixtures: For each bracket fixture, provide flanged metal stem attached to outlet box, with threaded end suitable for supporting the fixture rigidly in design position. Flanged part of fixture stud shall be of broad base type, secured to outlet box at not fewer than three (3) points.

Z. Top Relamping Fixtures: Top relamping fixtures shall have the necessary top-relamping screws loosened and moderately tightened, prior to installation, to assure ease of operation when relamping is required.

AA. Noise Quality Control: Replace noisy drivers/power supplies as directed, at no cost to the Owner.

BB. Mask the trims and bottoms of all lighting fixtures if necessary to protect the fixture during construction.

CC. At the completion of construction clean the bottoms, the trim, the reflecting surfaces, lenses, baffles, louvers and reflector cones of all lighting fixtures so as to render them free of any material, substance or film foreign to the fixture. If the luminaires are deemed dirty by the Architect at the completion of the project, the Contractor shall clean them at no additional cost to the Owner. Luminaire components whose finishes are damaged shall be replaced at no cost to the Owner. In addition, the Contractor shall vacuum and clean the control system including the interiors of the dimmer racks and control cabinets.

DD. Ascertain and ensure that all lamps installed are exactly as specified for each fixture type.

EE. Replace all burned-out or inoperative lamps (including LED lamps), and inoperative drivers/power supplies before the building is accepted by the Owner so that all lighting fixtures will be in first-class operating condition.

FF. Re-lamp all specified H.I.D. fixtures used as construction work lights with new specified lamps. No H.I.D. lamps shall have a burning hours difference that exceeds forty (40) hours.

GG. Re-lamp all specified incandescent fixtures used as construction work lights with new specified lamps. No incandescent lamps shall have a burning hours difference, which exceeds forty (40) hours.

HH. Provide labor and materials for final aiming of all adjustable fixtures under the Architect's supervision. Aiming shall take place immediately before building is turned over to Owner, after regular working hours where required.

II. Contractor will be responsible for supplying, renting, and delivery of any temporary storage facilities for lighting equipment while on job site.

3.2 TEST & ADJUST PHASE

A. Provide labor and materials for final aiming of all adjustable fixtures under the Architect's supervision. Aiming shall take place immediately before building is turned over to Owner, after regular working hours where required.

B. Contractor Installation Crew to provide an initial focus with (1) pass through each room. In addition, a touch-up focus call will be required where every light may get refocused once.

C. At completion of Test and Adjust Phase, Contractor will perform a “Walk Through” with the Architect. Punch List items will be noted and completed to the satisfaction of the Architect.

1. Confirm that all fixtures are working and both hard and soft patched per Lighting Designer’s paperwork before aiming and programming.
2. Provide labor and materials for final focus of all adjustable fixtures under the Lighting Designer’s supervision. Aiming shall take place immediately after building is considered “Dust Free”, after regular working hours where required.
3. Electrical Contractor to provide an initial focus with (1) pass through each room or exterior area. In addition, a touch-up focus call will be required where every light may get refocused once.
4. Electrical Contractor to provide Programmer for all aspects of programming the lighting system, including the following:

    a. Checking lighting system to insure proper patching.
    b. Operate consoles during focus of lighting system.
    c. Preliminary programming of cues, effects and sequences.
    d. Building detailed cue structures.
    e. Testing cue sequences with operation of ride vehicles and other special effects.
    f. Interfacing with Show Control and Building Management Systems to Lighting Control Systems.
    g. Revising cues based on notes from Production Team and Owners.
    h. Final storage of cues on Playback units.
    i. Reviewing operations to ensure proper playback of cue sequences and timing.
    j. Programming of necessary start of day, end of day and test sequences for proper operation and maintenance of lighting system.
    k. Any necessary training of staff to operate control system.
    l. Choice of Programmer will be approved by Lighting Designer from a list of qualified personnel (supplied by Lighting Designer).

5. Electrical Contractor will supply all necessary temporary tables, chairs and power distribution to allow programming throughout the attraction.
6. Electrical Contractor will provide at least 4, professional radios to allow communication between designers, programmers and focus staff.
7. Electrical Contractor to provide staff onsite to fix problems with the lighting system such as lamp failure and breaker tripping during programming. If necessary, additional crew will be available to fix any problems on separate shift when needed to avoid stoppage of programming.
8. At completion of Test and Adjust Phase, Electrical Contractor will perform a “Walk Through” with the Lighting Designer. Punch List items will be noted and completed to the satisfaction of the Lighting Designer.

3.3 TRAINING PHASE

A. At various times during the Installation, and Test and Adjust Phase the Integrator will interface with the Owners Maintenance and Operations staff to help train and handover the lighting system.

B. This includes general maintenance such as lamp replacement, power supply repair, fixture refocus (technical portion), and troubleshooting of major areas such as the control system.

3.4 ARCHIVAL PHASE

A. At the completion of the Programming Phase, and once all Punch List Items are accounted for the Contractor will supply the architect with a complete “As Built” set of drawings, specifications, and all manuals pertaining to purchased equipment along with any warranty information.

END OF SECTION 265100

SECTION 265200 - EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

Section includes emergency exit lighting and emergency egress lighting units, LED emergency drivers, lighting inverters and transfer switching devices.

1.2 RELATED SECTIONS

A. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

B. Section 260533.13 - Conduits for Electrical Systems.

C. Section 260519 - Low-Voltage Electrical Power Conductors and Cables.

D. Section 260533.16 - Boxes and Covers for Electrical Systems.

E. Section 260526 - Grounding and Bonding for Electrical Systems.

F. Section 260553 – Identification for Electrical Systems.

1.3 STANDARDS

A. UL 924

B. NFPA 101 - Life Safety Code.

C. NFPA 70 - National Electrical Code.

D. North Carolina State Building Code including Energy Code Volume X.

E. NEMA - Standards

1.4 SUBMITTALS FOR REVIEW

A. Submittals: Procedures for submittals. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

C. Product Data: Provide dimensions, ratings, and performance data.

1.5 SUBMITTALS FOR INFORMATION

A. Submittals: Submittals for information. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Submit manufacturer’s installation instructions. Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.6 SUBMITTALS FOR CLOSEOUT

A. Contract Closeout: Submittals for project closeout. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Submit manufacturer's operation and maintenance instructions for each product.

1.7 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.8 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Conform to requirements of NFPA 101.

C. Products: Listed and classified by testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated. Products shall also meet or exceed the standards listed in Part 2.

PART 2 - PRODUCTS

2.1 GENERAL

A. All lighting fixtures shall be listed as emergency lighting equipment and approved by third party testing agencies and NFPA and shall bear their label.

B. All fixtures shall have a stock, or standard finish unless otherwise specified.

C. All fixtures shall be completely self-contained, provided with maintenance free battery, automatic charger and other features. They shall be installed complete with lamps, batteries, etc. which shall be new and unused at time of final inspection of the project for acceptance.

D. Lighting fixture types shall be furnished as required by the Lighting Fixture Schedule on the contract drawings and as herein specified. Catalog numbers are provided as a guide to the design and quality of fixture desired. Equivalent designs and equal quality fixtures of other manufacturers listed will be acceptable upon approval of the Architect/Engineer. The Contractor shall verify from the contract drawings the type of ceilings or walls the fixture is to be used with and shall provide compatible mounting attachments and trim. Provide all accessories or additional materials required to maintain the ceiling fire rating as required by regulatory authorities.

E. Emergency lighting fixtures shall be as shown on the lighting fixture schedule on the contract drawings, and as herein specified.

F. Warranty: The entire unit shall be warranted for three years. The battery must have a additional two more years pro-rated warranty. Warranty shall date from the date of final project acceptance.

2.2 EMERGENCY LIGHTING (EGRESS) UNITS

A. Product Description: Self-contained LED emergency lighting unit automatically activated when the line voltage drops below 80%.

B. Battery: Ten year normal life expectancy, 6 or 12 volt, sealed, maintenance-free, lead calcium type,

with 1.5 hour minimum capacity at full load. Battery shall be a high temperature type with an operating range of 0° C. to 60º C., contain a resealable pressure vent and sintered positive and negative terminals. A low voltage disconnect switch shall be included if a lead battery is used, to disconnect the battery from the load and prevent damage from a deep discharge during an extended power outage.

C. Battery Charger: Automatic, solid state, full wave rectification, surge protected, current-limiting, dual-rate type, with filtered output of sufficient capacity to recharge discharged battery to full charge within twelve hours. Provide fused output circuit, low voltage battery disconnect, brownout and short circuit protection. Thermal protection shall sense circuitry temperature and adjust charge current to prevent overheating and charger failure. Thermal compensation shall adjust charger output to provide optimum charge voltage relative to ambient temperature. Regulated charge voltage shall maintain constant charge voltage over a wide range of line voltages. AC lockout circuit shall allow battery connection before AC power is applied and prevent battery damage due to deep discharge.

D. Lamps: LED. Heads shall rotate for aiming. Maximum LED failure rate shall be 25% within a seven (7) year period; otherwise, if exceeded, manufacturer shall replace the complete unit at no charge to the Owner.

E. Mounting: Surface wall or recessed ceiling as indicated by the drawings.

F. Housing: White polycarbonate, with steel backbox/housing or steel with white finish. Wall mount unit with hinged faceplate and adjustable mounting hardware. Ceiling mount unit with T bar hangar kit.

G. Self-Diagnostics: Electronics shall automatically, or manually upon demand, conduct self test on battery condition (including actual discharge), charger, lamps and internal wiring integrity per NEC and NFPA at prescribed intervals. A pilot light shall indicate the unit is connect to AC power. Provide test switch and visual indicator(s) of unit operational condition including charger status, ready and service code. Test switch shall simulate operation of the unit upon loss of AC power by energizing lamps from the battery, and also exercise the transfer relay.

H. Electrical Connection: Conduit connection.

I. Input Voltage: Dual voltage input (120/277 volts).

2.3 LED EMERGENCY DRIVER

A. Product Description: Manufacturer-installed UL924 LED emergency battery power supply suitable for installation in LED luminaire wireway. When normal AC power fails, the unit shall immediately drive the LED load at a reduced light output for a minimum of 90 minutes. When AC power is present, the emergency LED driver shall operate in various charging modes to ensure the sealed, maintenance-free, high-temperature nickel-cadmium batteries are fully recharged within 24 hours after a full discharge and remain fully charged until the next loss of AC power.

B. Battery: Seven to ten year normal life expectancy, 9.6 volt, sealed, maintenance-free, nickel-cadmium type, with 1.5 hour minimum capacity at 10 watts output. Battery shall be a high temperature type with an operating range of 32° F. to 122º F.

C. Provide with self-diagnostics module with status indicator light and test switch. Self-diagnostics shall automatically, or manually upon demand, conduct self test on battery condition (including actual discharge), charger, LEDs and internal wiring integrity per NEC and NFPA at prescribed intervals. Status light shall indicate operational condition including charger status, ready and service code. Test switch shall simulate operation of the unit upon loss of AC power by energizing lamps from the battery.

D. Input Voltage: Dual voltage input (120/277 volts).

2.4 EXIT LIGHTING UNITS

A. Product Description: Self-contained exit lighting unit automatically activated when the line voltage drops below 80%.

B. Battery: Ten year normal life expectancy, 6 or 12 volt, sealed, maintenance-free, lead calcium type, with 1.5 hour minimum capacity. Battery shall be a high temperature type with an operating range of 0º C. to 60º C. and contain a resealable pressure vent and sintered positive and negative terminals. A low voltage disconnect switch shall be included if lead battery is used, to disconnect the battery from the load and prevent damage from a deep discharge during an extended power outage.

C. Battery Charger: Automatic, solid state, surge protected, full wave rectification, current-limiting, dual-rate type, with filtered output of sufficient capacity to recharge discharged battery to full charge within twelve hours. Provide fused output circuit, low voltage battery disconnect, brownout and short circuit protection. Thermal protection shall sense circuitry temperature and adjust charge current to prevent overheating and charger failure. Thermal compensation shall adjust charger output to provide optimum charge voltage relative to ambient temperature. Regulated charge voltage shall maintain constant charge voltage over a wide range of line voltages. AC lockout circuit shall allow battery connection before AC power is applied and prevent battery damage due to deep discharge.

D. Lamps: LED, discrete or diffuse. Maximum failure rate shall be 25% within a seven year period, otherwise, if exceeded the manufacturer shall replace the entire unit at no cost to the Owner.

E. Face:

1. Standard Unit: Single or dual face as indicated or required. Translucent plastic face with red letters on white background.
2. Architectural/Edge Lit Unit: Clear transparent plastic panel with red letters on clear or mirrored background.

F. Directional Arrows: As indicated or universal type for field adjustment.

G. Mounting: Universal, surface wall, back or end mount, or ceiling, top or pendant mount.

H. Housing: White polycarbonate for standard unit, metallic enclosure with clear plexiglass signage panel for architectural/edge lit unit.

I. Self-Diagnostics: Electronics shall automatically, or manually upon demand, conduct self test on battery condition (including actual discharge), charger, lamps and internal wiring integrity per NEC and NFPA at prescribed intervals. Provide test switch and visual indicator(s) of unit operational condition including charger status, ready and service code. Test switch shall simulate operation of the unit upon loss of AC power by energizing lamps from the battery. This simulation shall also exercise the transfer relay.

J. Electrical Connection: Conduit connection.

K. Input Voltage: Dual voltage input (120/277 volts).

2.5 TRANSFER SWITCHING DEVICES

A. Transfer switching devices shall be provided for circuits and/or fixtures where noted on the Drawings. Devices shall be capable of bypassing local switching of the circuit or fixture when the

emergency generator or other emergency power source is supplying power to the facility or lighting circuit, and/or the fire detection and alarm system alarms, energizing the circuit or fixture from the emergency power source regardless of local switch position.

B. Fixture devices shall be UL 924 listed for field installation inside the ballast channel or on top of the fixture. It shall be rated for 3 amperes load at rated voltage and shall consist of relay switching circuitry and be contained in a NEMA-1 enclosure. The device shall be capable of overriding a 0-10V dimmer to full brightness. The device shall be multivoltage (120 or 277 V), or the proper single voltage device shall be provided.

C. Circuit devices shall be UL 924 listed for field installation at a location shown or field directed. It shall be rated for up to 20 amperes load at rated voltage and shall consist of relay switching circuitry and be contained in a NEMA-1 enclosure. The device shall be capable of overriding a 0-10V dimmer to full brightness. The device shall be multivoltage (120 or 277 V), or the proper single voltage device shall be provided.

D. Devices shall be warranted for a minimum of five (5) years by the manufacturer.

E. Devices shall be Bodine GTD series, Dual Lite ATSD series, Functional Devices ESR series or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install suspended exit signs using pendants supported from swivel hangers. Provide pendant length required to suspend sign at indicated height.

B. Install surface-mounted emergency lighting units and exit signs plumb and adjust to align with building lines and with each other. Secure to prevent movement.

C. Install wall-mounted emergency lighting units and exit signs at height as indicated.

D. Install accessories furnished with each emergency lighting unit and exit sign.

E. Emergency and exit lighting fixtures shall be installed in a manner to be fully compliant with the seismic restraint requirements of the North Carolina State Building Code. Provide mounting devices and hardware, bracing, fittings, etc. as required for seismic restraint. See Specifications Section 260500, Paragraph 1.23 for additional requirements.

F. Connect emergency lighting units and exit signs to branch circuit outlets provided under this Division as indicated.

G. Exposed Grid Ceilings: Support surface mounted luminaires on grid ceiling directly from building structure. Provide auxiliary members spanning ceiling grid members to support surface mounted luminaires. Fasten surface mounted luminaires to ceiling grid members using bolts or screws.

H. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within unit.

I. Install specified lamps in each emergency lighting unit.

J. Ground and bond emergency lighting units and exit signs under the provisions of Section 260526.

K. Locate exit and emergency lighting fixtures as indicated on reflected ceiling plan.

L. Install recessed luminaires to permit removal from below.

M. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

N. Install screws to secure recessed grid-supported luminaires in place.

O. Install accessories furnished with each luminaire.

P. Paint a 3/8" diameter red dot on each emergency lighting fixture to provide ready identification of emergency fixtures. Exact location shall be coordinated with the Architect/Engineer.

3.2 FIELD QUALITY CONTROL

A. Quality Assurance: Field inspection, testing and adjusting shall be as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

3.3 ADJUSTING

A. Contract Closeout: Adjust installed work as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Aim and adjust emergency lighting fixture heads to illuminate paths of egress.

3.4 CLEANING

A. Contract Closeout: Clean installed work as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Clean electrical parts to remove conductive and deleterious materials.

C. Remove dirt and debris from enclosures.

D. Clean photometric control surfaces as recommended by manufacturer.

E. Clean finishes and touch up damage.

3.5 DEMONSTRATION AND INSTRUCTIONS

A. Contract Closeout: Demonstrate installed work as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. The Contractor shall perform a test on each unit after it is permanently installed and charged for a minimum of 24 hours. Battery shall be tested for 90 minutes, in accordance with NEC 700. If the battery is not user accessible, the test shall be done by measuring the light output using a light meter at a fixed position at the start and end of the 90 minute test. Battery voltage or light output shall be 87.5% minimum of the initial measurement after 90 minutes run time to pass the test. Any unit which fails the test shall be repaired or replaced, and tested again. A copy of the test report shall be presented at final inspection and included in the Owner's Operation and Maintenance Manual. Include starting voltage, ending voltage, and percent voltage drop in the test report. The Architect/Engineer will provide the testing form for contractor use.

C. Demonstrate normal luminaire operation for minimum of ninety minutes after the unit has been permanently installed and charged for a minimum of 24 hours. The battery run time test shall be completed a minimum of 10 days prior to final inspection by Architect and representatives of the North Carolina State Construction Office. Any unit which fails the test shall be repaired or replaced, and tested again. A copy of the test report shall be sent to the North Carolina State Construction Office, through the Architect. The Architect/Engineer will provide the testing form for contractor use.

3.6 PROTECTION OF FINISHED WORK

A. Contract Closeout: Protect installed work as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Relamp emergency lighting units and exit signs that have failed lamps at Substantial Completion. Replace exit signs in which more than 5% of the LEDs have failed lamps at Substantial Completion.

END OF SECTION 265200

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SECTION 265600 - SITE LIGHTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Exterior luminaires and accessories.

B. LED Modules.

C. Poles.

D. Bollard fixtures.

1.2 RELATED SECTIONS

A. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.

B. Division 3: Cast-in-Place Concrete: Foundations for poles.

C. Section 260533.13 - Conduits for Electrical Systems.

D. Section 260519 - Low-Voltage Electrical Power Conductors and Cables.

E. Section 260526 - Grounding and Bonding for Electrical Systems.

1.3 REFERENCES

A. IES RP-20 - Lighting for Parking Facilities.

B. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS FOR REVIEW

A. Procedures for submittals. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Shop Drawings: Indicate dimensions and components for each luminaire which is not a standard Product of the manufacturer.

C. Product Data: Provide dimensions, ratings, and performance data.

1.5 SUBMITTALS FOR INFORMATION

A. Submittals for information. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Test Reports: Indicate measured illumination levels.

C. Submit manufacturer’s installation instructions. Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.6 SUBMITTALS FOR CLOSEOUT

A. Operation and Maintenance Data: Submittals for project closeout. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Maintenance Data: For each luminaire.

1.7 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.8 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.9 DELIVERY, STORAGE, AND HANDLING

Transport, handle, store, and protect products as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

1.10 COORDINATION

A. Coordination as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Furnish bolt templates and pole mounting accessories to installer of pole foundations.

1.11 EXTRA PRODUCTS

A. General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Furnish two of each type and wattage LED module installed.

PART 2 - PRODUCTS

2.1 LUMINAIRES AND ACCESSORIES

Furnish Products as scheduled. Refer to provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections for substitutions and product options.

2.2 LAMPS

A. Lamp Types: As specified for luminaire. LED sources shall be as noted on the drawings.

2.3 POLES

A. Material and Finish: As indicated on the Drawings.

B. Section Shape and Dimensions: As indicated on the Drawings.

C. Height: As indicated on the Drawings.

D. Base: Anchor. Refer to pole base detail on Drawings.

E. Accessories:
1. Gasketed Handhole.
2. Anchor bolts.
3. Waterproof fuseholders in each phase conductor feeding the luminaire with KTK type fuses sized for approximately 150% of fixture current, or as recommended by the ballast or fixture manufacturer. Fuseholders shall be installed in pole and lighting bollard handholes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide concrete bases for lighting poles and bollards at locations indicated, in accordance with Division 3.

B. Install poles and lighting bollards plumb. Provide shims or double nuts to adjust plumb. Grout around each base. Install lamps in each luminaire.

C. Bond luminaires, metal accessories, metal lighting bollards and poles to branch circuit equipment grounding conductor. Provide supplementary grounding electrode at each pole.

3.2 FIELD QUALITY CONTROL

A. Starting of Systems: Field inspection, testing, adjusting shall be as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Operate each luminaire after installation and connection. Inspect for improper connections and operation.

C. Measure illumination levels to verify conformance with performance requirements.

D. Take measurements during night sky, without moon or with heavy overcast clouds effectively obscuring moon.

3.3 ADJUSTING

A. Adjust installed work as required.

B. Aim and adjust luminaires to provide illumination levels and distribution as directed.

3.4 CLEANING

A. Clean installed work as required.

B. Clean electrical parts to remove conductive and deleterious materials.

C. Remove dirt and debris from enclosure.

D. Clean photometric control surfaces as recommended by manufacturer.

E. Clean finishes and touch up damage.

3.5 PROTECTION OF FINISHED WORK

A. Protect installed work as required.

B. Relamp luminaires which have failed lamps at Substantial Completion. Replace LED modules in which more than 5% of the LEDs have failed lamps at Substantial Completion.

END OF SECTION 265600

SECTION 265613 - LIGHTING POLES AND STANDARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Aluminum poles.
2. Pole accessories.
3. Mounting hardware.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 DEFINITIONS

A. EPA: Equivalent projected area.

B. Pole: Luminaire-supporting structure, including tower used for large-area illumination.

C. Standard: See "Pole."

1.3 ACTION SUBMITTALS

A. Product Data:
1. Aluminum poles.
2. Pole accessories.
3. Mounting hardware.

B. Shop Drawings:

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of poles and pole accessories.
4. Foundation construction details, including material descriptions, dimensions, anchor bolts, support devices, and calculations, signed and sealed by a professional engineer licensed in the state of installation.
5. Anchor bolt templates keyed to specific poles and certified by manufacturer.
6. Method and procedure of pole installation. Include manufacturer's written installations.

C. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Material Test Reports:

1. For each foundation component, by qualified testing laboratory.
2. For each pole, by qualified testing laboratory.

B. Soil test reports.

C. Manufacturers' published instructions.

D. Field Reports:

1. Manufacturer's field reports for field quality-control support.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts and Special Tools: Furnish to Owner spare parts, proprietary equipment, and keys required to operate, maintain, repair, adjust, or implement future changes to poles, that are packaged with protective covering for storage on-site and identified with labels describing contents.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping in accordance with ASTM B660.

B. Store poles on decay-resistant skids at least 12 inch above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on metal poles until right before pole installation. Handle poles with web fabric straps.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Characteristics: Comply with AASHTO LTS-6-M.

B. Dead Load: Weight of luminaire and its horizontal and vertical supports and supporting structure, applied in accordance with AASHTO LTS-6-M.

C. Live Load: Single load of 500 lb distributed in accordance with AASHTO LTS-6-M.

D. Ice Load: Load of 3 lb/ft^2, applied in accordance with AASHTO LTS-6-M for applicable areas on the Ice Load Map.

E. Wind Load for Poles Not Exceeding 50 ft (15 m) Height:

1. Basic Wind Speed: 150 mile/h.
2. Wind Importance Factor: 1.0.

3. Minimum Design Life: 25 years.
4. Velocity Conversion Factor: 1.3.

F. Strength Analysis: For each pole, multiply the actual EPA of luminaires and brackets by a factor of 1.1 to obtain the EPA used in pole selection strength analysis.

G. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless steel fasteners and mounting bolts unless otherwise indicated.

H. General Finish Requirements:

1. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
2. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.2 ALUMINUM POLES

A. Poles: Seamless, extruded structural tube complying with ASTM B221, Alloy 6063-T6, with access handhole in in pole wall.

1. Shape: Round, straight.
2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

B. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

C. Grounding and Bonding Lugs: Bolted 1/2 inch threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

D. Fasteners: Stainless steel, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.

1. Materials: Compatible with poles and standards as well as to substrates to which poles and standards are fastened and may not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

E. Handhole: Oval shaped, with minimum clear opening of 2-1/2-by-5 inch, with cover secured by stainless steel captive screws.

F. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I clear coating of 0.018 mm or thicker), complying with AAMA 611.

G. Powder-Coat Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair powder coat bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, in accordance with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2. Powder coat must comply with AAMA 2604.

a. Electrostatic applied powder coating; single application with a minimum 2.5 to 3.5 mil dry film thickness; cured in accordance with manufacturer's instructions. Coat interior and exterior of pole for equal corrosion protection.
b. Color: As selected by Architect from manufacturer's full range.

2.3 POLE ACCESSORIES

A. Base Covers: Manufacturers' standard metal units, finished same as pole, and arranged to cover pole's mounting bolts and nuts.

B. Decorative accessories, supplied by decorative pole manufacturer, include the following:

2.4 MOUNTING HARDWARE

A. Anchor Bolts: Manufactured to ASTM F1554, Grade 55, with a minimum yield strength of 55,000 psi.

1. Galvanizing: Hot dip galvanized in accordance with ASTM A153, Class C.
2. Bent rods as supplied by manufacturer.

B. Nuts: ASTM A563, Grade A, Heavy-Hex.

1. Galvanizing: Hot dip galvanized in accordance with ASTM A153, Class C.

C. Washers: ASTM F436, Type 1.

1. Galvanizing: Hot dip galvanized in accordance with ASTM A153, Class C.

2.5 SOURCE QUALITY CONTROL

A. Product Data: Prepare and submit catalog cuts, brochures, diagrams, schedules, and performance data illustrating size, physical appearance, and other characteristics of product.

1. Include data on construction details, profiles, EPA, cable entrances, materials, dimensions, weight, rated design load, and ultimate strength of individual components.
2. Include finishes for lighting poles and luminaire-supporting devices.
3. Anchor bolts.
4. Manufactured pole foundations.
5. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in accordance with AASHTO LTS-6-M and that load imposed by luminaire and attachments has been included in design. The certification must be based on design calculations signed and sealed by a professional engineer.

6. Include sample warranty language.

B. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. Samples: Submit finish samples for each exposed lighting pole, standard, and luminaire-supporting device and for each color and texture specified.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine poles, luminaire-mounting devices, lowering devices, and pole accessories before installation. Components that are scratched, dented, marred, wet, moisture damaged, or visibly damaged are considered defective.

C. Examine roughing-in for foundation and conduit to verify actual locations of installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 POLE FOUNDATION

A. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Structural steel complying with ASTM A36/A36M and hot-dip galvanized in accordance with ASTM A123/A123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

B. Anchor Bolts: Install plumb using manufacturer-supplied template, uniformly spaced.

3.3 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on pole.

B. Concrete Pole Foundations: Set anchor bolts in accordance with anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."

C. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level in accordance with pole manufacturer's written instructions.

1. Use anchor bolts and nuts selected to resist seismic forces specified for the application and approved by manufacturer.
2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
3. Install base covers unless otherwise indicated.

4. Use a short piece of 1/2 inch diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

D. Poles and Pole Foundations Set in Concrete-Paved Areas: Install poles with a minimum 6 inch wide, unpaved gap between the pole or pole foundation and the edge of the adjacent concrete slab. Fill unpaved ring with pea gravel. Insert material to a level 1 inch below top of concrete slab.

E. Raise and set pole using web fabric slings (not chain or cable) at locations indicated by manufacturer.

3.4 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum using insulating fittings or treatment.

B. Steel Conduits: Comply with requirements in Section 260533.13 "Conduits for Electrical Systems." In concrete foundations, wrap conduit with 0.010 inch thick, pipe-wrapping plastic tape applied with a 50-percent overlap.

3.5 GROUNDING

A. Ground Metal Poles and Support Structures: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground Nonmetallic Poles and Support Structures: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole.
2. Install grounding conductor and conductor protector.
3. Ground metallic components of pole accessories and foundation.

3.6 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.7 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by Architect.

B. Tests and Inspections:

1. Inspect poles for nicks, mars, dents, scratches, and other damage.
2. System function tests.

C. Nonconforming Work:

1. Unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

D. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

END OF SECTION 265613

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SECTION 265650 – ELECTRICAL SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Commissioning of Divisions 26, 27 and 28 is the responsibility of the Contractor.

B. Commissioning and placing into service of all newly installed and retrofitted electrical power equipment and systems.

C. Work of Divisions 26, 27 and 28 includes:
   1. Contractor preparation for testing and start-up of the electrical equipment.
   2. Providing qualified and manufacturer trained and certified personnel to conduct/assist in tests.
   3. Provide factory-authorized startup of:
      a. Section 263213 – Engine-Generator Systems.
      b. Section 263600 – Automatic Transfer Switches.
      c. Section 262419 – Motor Control Centers.
      d. Section 271500 – Data Circuits.
      e. Section 283111 – Fire Detection and Alarm System.
   4. Static and operational testing and start-up of the electrical equipment.
   5. Providing equipment, materials and test instrumentation necessary to conduct testing.
   6. Providing equipment, materials, test instrumentation and labor necessary to correct deficiencies found during the commissioning process which fulfills contract and warranty requirements.
   7. Providing operation and maintenance information and as-built drawings.
   8. Providing Owner training for the systems specified in this and other Divisions.

1.2 RELATED WORK

A. All testing and start-up procedures and documentation requirements specified within Divisions 26, 27 and 28 and related portions of this project.

B. Commissioning procedures that require the participation of other Division Contractors.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Division 26 shall provide standard and specialized test equipment as necessary to test and start up the electrical systems.

B. Proprietary test equipment required by the equipment manufacturer, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process.

PART 3 - EXECUTION

3.1 WORK PRIOR TO COMMISSIONING

A. Complete all phases of work so the systems can be energized, started, tested, and otherwise commissioned. Division 26 has primary start-up responsibilities with obligations to complete systems, including all sub-systems so they are functional. This

includes the complete installation of all equipment, materials, raceways, wire, terminations, controls, etc., per the Contract Documents and related directives, clarifications, change orders, etc.

B. Specific responsibilities of Division 26 are as follows:
   1. Normal start-up services required to bring each system into a fully operational state. This includes motor rotational check, cleaning, lug tightening, control sequences of operation, etc.
   2. Factory start-up services shall be provided for key equipment noted above and systems specified in Divisions 26, 27 and 28.

C. Commissioning is intended to begin upon completion of a system. Commissioning may proceed prior to the completion of systems and/or sub-systems, if expediting this work is in the best interests of the Owner. Commissioning activities and schedule shall be coordinated by the Contractor. Start of commissioning before system completion will not relieve the Contractor from completing those systems as per the schedule.

3.2 PARTICIPATION IN COMMISSIONING

A. Provide skilled technicians to start-up and debug all systems within Divisions 26, 27 and 28. Contractor must ensure the qualified technician(s) are available and present during the agreed-upon schedules and of sufficient duration to complete the necessary tests, adjustments, and/or problem resolutions.

B. System problems and discrepancies may require additional technician time, redesign and/or reconstruction of systems, and system components. The additional technician time shall be made available for the subsequent commissioning periods until the required system performance is obtained.

3.3 WORK TO RESOLVE DEFICIENCIES

A. In some systems, miss-adjustments, misapplied equipment, and/or deficient performance under varying loads will result in additional work being required to commission the systems. This work shall be completed under the direction of the Architect, with input from the Contractor and equipment supplier. Whereas all members will have input and the opportunity to discuss, debate, and work out problems, the Architect shall have final jurisdiction on the necessary work to be done to achieve performance.

B. Corrective work shall be completed in a timely fashion to permit the timely completion of the commissioning process. Experimentation to render system performance will be permitted. If the completion deadline(s) passes without resolution of the problem, the Owner reserves the right to obtain supplementary services and/or equipment to resolve the problem. Costs incurred to solve the problems in an expeditious manner will be the Contractor's responsibility.

3.4 TRAINING

A. This Contractor shall provide training of the Owner's maintenance staff for each electrical system and the related components. Training may be conducted in a classroom setting, with system and component documentation, and suitable classroom training aids, or in the field with the specific equipment. The type of training will be the Owner's option.

B. Training will be conducted jointly with the Architect, the Engineer, the equipment vendors, and the Contractor. The Contractor will be responsible for the generic training, as well as instructing the Owner's staff on the system peculiarities specific to this project.

3.5 SYSTEMS DOCUMENTATION

A. Upon completion of all commissioning activities, documentation of all commissioning activities shall be included in final project operation and maintenance manual which shall be submitted to the Architect/Engineer for approval.

B. In addition to the requirements of Division 1, update Contract Documents to incorporate field changes and revisions to system designs to account for actual constructed configurations. All drawings shall be red lined on two sets. Division 26 as-built drawings shall include updated architectural floor plans, and the individual electrical systems in relation to actual building layout.

C. Maintain as-built red lines on the job site as required in Division 01. Given the size and complexity of this project, red lining of the drawings at completion of construction, based on memory of key personnel, is not satisfactory. Continuous and regular red lining and/or posting of drawings is essential and mandatory.

END OF SECTION 265650

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SECTION 270510 - TELECOMMUNICATIONS PATHWAYS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Equipment and terminal backboards.

B. Premises wiring raceways and outlets.

1.2 RELATED SECTIONS

A. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

B. Section 260526 - Grounding and Bonding for Electrical Systems.

C. Section 260529 - Hangers and Supports for Electrical Systems.

D. Section 260533.16 - Boxes and Covers for Electrical Systems.

E. Section 260533.23 - Surface Raceways for Electrical Systems.

F. Section 260553 – Identification for Electrical Systems.

G. Section 271323 - Communications Optical Fiber Backbone Cabling.

H. Section 271513 - Communications Copper Horizontal Cabling.

1.3 REFERENCES

NFPA 70 - National Electrical Code.

1.4 SYSTEM DESCRIPTION

Individual and combination telecommunications/data outlets shall be installed where shown on the contract drawings. Raceways shall be installed as straight as possible and shall contain not more than the equivalent of three quarter bends.

1.5 PROJECT RECORD DOCUMENTS

A. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Record actual locations and sizes of pathways and outlets.

1.6 QUALITY ASSURANCE

A. Telephone Utility: Field verify.

B. Perform Work in accordance with telephone utility's rules and regulations.

PART 2 - PRODUCTS

2.1 TELECOM TERMINATION BACKBOARDS

A. Material: Grade A/C Fire retardant treated plywood.

B. Size: 4 x 8 feet (1.2 x 2.4 m), 3/4 inch (19 mm) thick.

2.2 TELECOMMUNICATIONS OUTLETS

Outlets shall consist of standard, square cornered boxes 4-11/16” wide by 4-11/16“ high by 2-1/8” deep, minimum, flush mounted at the height indicated on the contract drawings.

2.3 TELECOM WIRE AND CABLE

All telephone and data cable shall be furnished and installed by the Electrical Contractor as specified in the above referenced sections.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Finish paint termination backboards with durable white enamel under the provisions of Division 9 prior to installation of equipment.

B. Support raceways and backboards under the provisions of Section 260529.

C. The maximum bends between pull points shall be 180 degrees.

D. The maximum distance between pull boxes shall be 100 feet.

E. Install termination backboards plumb, and attach securely to building wall at each corner.

F. Install #14 gauge steel or approved, 200 lb. nylon cord pull wire in each empty conduit run.

END OF SECTION 270510

SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Communications-circuit accessories.

B. Products Installed, but Not Furnished, under This Section:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

2. Section 061053 "Miscellaneous Rough Carpentry" furnishes equipment backing panels installed by this Section.
3. Section 260526 "Grounding and Bonding for Electrical Systems" furnishes the following installed by this Section:

    a. Grounding and bonding conductors.
    b. Grounding and bonding clamps.
    c. Grounding and bonding bushings.
    d. Grounding and bonding hubs.
    e. Grounding and bonding connectors.
    f. Intersystem bonding bridge grounding connector.
    g. Grounding and bonding busbars.

4. Section 260529 "Hangers and Supports for Electrical Systems" furnishes hangers, supports, and concrete bases for communications equipment installed by this Section.
5. Section 260533.16 "Boxes and Covers for Electrical Systems" furnishes the following installed by this Section:

    a. Metallic outlet boxes, device boxes, rings, and covers.
    b. Junction boxes and pull boxes.
    c. Cover plates for device boxes.

6. Section 260553 "Identification for Electrical Systems" furnishes labels and warning signs for communications pathways installed by this Section.

7. Section 262726 "Wiring Devices" furnishes duplex receptacles installed by this Section.

1.2 DEFINITIONS

A. Abbreviations for Communications Spaces:
1. TR: Telecommunications room; generally serves a single tenant or floor.

B. Abbreviations for Communications Facilities:

1. HC: Horizontal cross-connect; also called "floor distributor" (FD).
2. IC: Intermediate cross-connect; also called "building distributor" (BD).

3. MC: Main cross-connect; also called "campus distributor" (CD).

C. Abbreviations for Grounding and Bonding:
1. RBB: Rack bonding busbar; located in equipment cabinets and racks.
2. SBB: Secondary bonding busbar; located in intermediate distribution frame rooms.
3. TBB: Telecommunications bonding backbone, for connecting SBBs to PBB.
4. TEBC: Telecommunications equipment bonding conductor, for connecting RBBs to SBBs or PBB.
5. UBC: Unit bonding conductor, for connecting individual communications equipment to RBBs or SBBs.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Shop Drawings:

1. Communications equipment room drawings, diagrams, and supporting documents.

PART 2 - PRODUCTS

2.1 COMMUNICATIONS-CIRCUIT ACCESSORIES

A. Description: This category covers devices intended for connecting communications circuits in accordance with Article 800 of NFPA 70.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria:

a. For Communications Circuits: UL CCN DUXR; including UL 1863 and UL 467.
b. For Audio/Video, Data, and Signaling Circuits: UL CCN DUXR; including UL 1977 and UL 467.

C. UL DUXR - 66-Style or 110-Style Cross-Connect Frame:

1. Match Owner’s existing.
2. Source Limitations: Obtain products from single manufacturer.
3. Description: This product type includes the frame only. Block inserts and related termination equipment are specified in communications cabling Sections.

D. UL DUXR - Patch Panel:

1. Match Owner’s existing.
2. Source Limitations: Obtain products from single manufacturer.
3. Product Characteristics:

a. Mounting: Equipment rack or Wall rack.
b. Style: Modular.
c. EMI Compatibility: Unshielded.
d. Configuration: Standard; flat.
e. Include provisions for labeling ports.

4. Required Product Options:

a. Distribution Port Quantity: As required with 25% spare capacity.
b. Cable Type: Cat. 6.

PART 3 - EXECUTION

3.1 PREPARATION

A. Shop Drawings: Prepare and submit the following:

1. Communications Equipment Room Drawings, Diagrams, and Supporting Documents:

a. Include plans, elevations, sections, details, and attachments to other work.
b. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
c. Equipment Racks and Cabinets: Indicate workspace requirements and access for cable connections.
d. Switchboards, Panelboards, and Safety Switches: Indicate workspace requirements and access for cable connections.
e. Grounding and Bonding: Indicate location of busbars and their mounting details showing standoff insulators and wall mounting brackets.
f. Cable Trays, Large Raceways, Ducts, and Piping: Indicate elevation and route of vertical and horizontal cable trays, raceways or ducts larger than 2 inch (50 mm) wide, and fire-suppression piping located inside communications equipment room.
g. Luminaires: Indicate elevation, orientation, and size of luminaires inside the communications equipment room for coordination with cable trays, equipment racks, cabinets, and other equipment.
h. Access Panels: Indicate locations, dimensions, and clearances required to open access panels in ducts, walls, or ceilings inside communications equipment room.
i. Controls: Indicate locations of sensors, switches, and push-buttons for HVAC, fire suppression, fire alarm, and standby power.
j. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize configurations and space requirements of communications equipment.
k. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.
l. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

B. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

3.2 SELECTION OF GROUNDING AND BONDING PRODUCTS FOR COMMUNICATIONS

A. Grounding and Bonding Conductors: See Drawings.

B. Grounding and Bonding Busbars: See Drawings.

3.3 INSTALLATION OF BONDING FOR COMMUNICATIONS

A. Grounding of Communications: Bond grounding conductors as shown on the Drawings.

B. Comply with manufacturer's published instructions.

C. Reference Standards:

1. Bonding of Communications: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with BICSI N3.
2. Consult Architect for resolution of conflicting requirements.

D. Special Techniques:

1. Bonding of Busbars:

   a. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 12 inch above finished floor unless otherwise indicated.
   b. Where busbars are indicated on both sides of doorways, route bonding conductor up to top of door frame, across top of doorway, and down; connect to continuation of horizontal busbar.

2. Bonding Conductors:

   a. Stacking of conductors under a single bolt is not permitted when connecting to busbars.
   b. Assemble wire connector to conductor, complying with manufacturer's published instructions and as follows:

      1) Use crimping tool and die specific to connector.
      2) Pretwist conductor.
      3) Apply antioxidant compound to bolted and compression connections.

   c. Install in straightest and shortest route between origination and termination point, and no longer than required. Bend radius must not be smaller than 10 times diameter of conductor. No single bend may exceed 90 degrees.
   d. Install without splices.
   e. Support conductors at not more than 36 inch intervals.

3.4 FIELD QUALITY CONTROL FOR BONDING OF COMMUNICATIONS

A. Field tests and inspections must be witnessed by Architect.

B. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench according to manufacturer's published instructions.
2. Test bonding connections of system using AC earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing PBB or SBB, using process recommended by BICSI N1. Conduct tests with facility in operation.

    a. Measure resistance between PBB and electrical service intersystem termination point. Maximum acceptable value is 100 mΩ.

        1) If measured resistance from electrical service equipment to ground exceeds 5 Ω, notify Architect and include recommendations to reduce resistance to ground.

    b. Measure resistance between SBBs and PBB. Maximum acceptable value is 100 mΩ.

3. Test for ground loop currents using digital clamp-on ammeter, with full scale not more than 10 A, displaying current in increments of 0.01 A at accuracy of plus or minus 2.0 percent.

    a. With grounding infrastructure completed and communications system electronics operating, measure current in bonding conductors connected to PBB and to SBBs. Maximum acceptable AC current level is 1 A.

C. Nonconforming Work:

1. Communications bonding will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

D. Collect, assemble, and submit test and inspection reports.

3.5 PROTECTION

A. After installation, protect communications equipment room fittings from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 271100

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SECTION 271323 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Type OFNP optical fiber cable.
   2. Optical fiber cable hardware.

1.2 DEFINITIONS

A. Cross-Connect: A facility enabling termination of cable elements and their interconnection or cross-connection.

B. Type OFNP: Nonconductive cable for use in plenums, ducts, and other spaces used for environmental air.

1.3 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

1.4 ACTION SUBMITTALS

A. Product Data:
   1. Type OFNP optical fiber cable.
   2. Optical fiber cable hardware.

B. Shop Drawings:

   1. System Labeling Schedules:

      a. Electronic copy of labeling schedules, in software and format selected by Owner.
      b. Electronic copy of labeling schedules that are part of cabling and asset identification system of software.

   2. Cabling administration drawings and printouts.
   3. Wiring diagrams showing typical schematic arrangement, including the following:

      a. Telecommunications rooms plans and elevations.
      b. Telecommunications pathways.
      c. Telecommunications system access points.
      d. Telecommunications grounding system.
      e. Cross-connects.
      f. Patch panels.
      g. Patch cords.

   4. Cross-Connect and Patch-Panel Drawings: Detail mounting assemblies and show elevations and physical relationship between installed components.

C. Certificates: For each type of product.

D. Field Quality-Control Reports: Optical fiber cable testing plan.

1.5 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Software service agreement.

B. Maintenance Data: For optical fiber cable, splices, and connectors.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet-work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during remainder of construction period.

B. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine continuity of strand end to end. Use optical loss test set.
2. Test optical fiber cable while on reels. Use optical time domain reflectometer to verify cable length and locate cable defects, splices, and connector, including loss value of each. Retain test data and include record in maintenance data.

PART 2 - PRODUCTS

2.1 TYPE OFNP OPTICAL FIBER CABLE

A. Type OFNP Optical Fiber Cable: This category covers jacketed optical fiber cable for use in vertical runs in plenums, ducts, or other spaces used for environmental air within buildings in accordance with Article 770 of NFPA 70 containing no electrically conductive materials.

B. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN QAYK; including UL 1651.
3. General Characteristics:

a. Performance: TIA-568.3.
b. Inside Plant Mechanical Properties: ICEA S-83-596.
c. Inside-Outside Plant Mechanical Properties: ICEA S-104-696.

d. Jacket:

1) Cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
2) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inch.

C. Type OFNP, Designation OM3, Multimode Optical Fiber Cable.
1. Match Owner's existing.
2. Source Limitations: Obtain products from single manufacturer.
3. Additional Characteristics:

a. Construction: TIA-492AAAC; 850 nm laser-optimized, 50 µm core diameter, 125 µm cladding diameter.
b. Minimum Overfilled Modal Bandwidth-Length Product: 1500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
c. Minimum Effective Modal Bandwidth-Length Product: 2000 MHz-km at 850 nm wavelength.

4. Options:

a. Configuration: 6-fiber, tight buffer, optical fiber cable.
b. Maximum Attenuation: 3.50 dB/km at 850 nm wavelength; 1.5 dB/km at 1300 nm wavelength.
c. Jacket Color: Black.

2.2 OPTICAL FIBER CABLE HARDWARE

A. Match Owner's existing.

B. Performance Criteria:

1. Fiber Optic Connector Intermateability Standard (FOCIS) specifications of TIA-604 series.
2. TIA-568.3.

C. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

D. Patch Cords: Factory-made, dual-fiber cables in 36 inch lengths.

E. Connector Type: Use type in use by the Owner.

F. Plugs and Plug Assemblies:

1. Male; color-coded modular telecommunications connector designed for termination of single optical fiber cable.
2. Insertion loss not more than 0.25 dB.
3. Marked to indicate transmission performance.

G. Jacks and Jack Assemblies:

1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of single optical fiber cable.
2. Insertion loss not more than 0.25 dB.
3. Marked to indicate transmission performance.
4. Designed to snap-in to patch panel or faceplate.

2.3 SOURCE QUALITY CONTROL

A. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

B. Testing Administrant: Engage qualified testing agency to evaluate cables.

C. Factory Tests and Inspections:

1. Test and inspect multimode optical fiber cables, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with TIA-526-14 and TIA-568.3 before delivering to site. Affix label with name and date of manufacturer's certification of system compliance.
2. Test and inspect pre-terminated optical fiber cable assemblies, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with TIA-526-14 and TIA-568.3 before delivering to site. Affix label with name and date of manufacturer's certification of system compliance.

D. Nonconforming Work:

1. Cables that do not pass tests and inspections will be considered defective.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate backbone cabling with protectors and demarcation point provided by communications service provider.

3.2 SELECTION OF OPTICAL FIBER TYPE

A. Installed in Vertical Shaft or Floor-to-Floor Riser:

1. Nonconductive:

a. Type OFNP.

B. Installed in Plenum, Duct, or Other Space Handling Environmental Air:

1. Nonconductive:

a. Type OFNP

C. Installed in Location Other Than Riser or Plenum:

1. Nonconductive: Type OFNP.

3.3 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

A. Optical fiber backbone cabling system must provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters may not be used as part of backbone cabling.

C. Comply with BICSI N1, NECA NEIS 1, and NECA NEIS 301.

D. Backbone cabling system must comply with transmission standards in TIA-568.1.

E. Telecommunications Pathways and Spaces: Comply with TIA-569.

F. Wiring Methods:

1. Not in Raceway: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
2. Exposed: Install cables on J hooks as high as possible.

    a. Install plenum cable in environmental airspaces, including plenum ceilings.
    b. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."

3. In Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

G. Optical Fiber Cabling Installation:

1. Comply with TIA-568.1 and TIA-568.3.
2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
3. Terminate all cables; no cable may contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inch and not more than 6 inch from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps may not be used for heating.

9. In communications equipment room, provide 10 ft long service loop on each end of cable.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

H. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable may not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

I. Group connecting hardware for cables into separate logical fields.

3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569, Annex A, "Firestopping."

C. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Cable Schedule: Install in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish electronic copy of final comprehensive schedules for Project.

C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

D. Cable and Wire Identification:

1. Label each cable within 4 inch of each termination and tap, where it is accessible in cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 ft.
4. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use different color for jacks and plugs of each service.

E. Labels must be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606, for the following:

1. Flexible vinyl or polyester that flexes as cables are bent.

3.6 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

B. Field tests and inspections must be witnessed by Architect.

C. Tests and Inspections:

1. Visually inspect optical fiber jacket materials for qualified electrical testing laboratory certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Optical Fiber Cable Tests:

    a. Test instruments must meet or exceed applicable requirements in TIA-568.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:

        1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in one direction in accordance with TIA-526-14, Method B, One Reference Jumper.
        2) Attenuation test results for backbone links must be less than 2.0 dB. Attenuation test results must be less than those calculated in accordance with equation in TIA-568.1.

D. Nonconforming Work:

1. Cables will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective cables and retest.

E. Collect, assemble, and submit test and inspection reports.

1. Data for each measurement must be documented.
2. Data for field quality-control report submittals must be printed in summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from instrument to computer, saved as text files, and printed and submitted.

F. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

3.7 MAINTENANCE

A. Software Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software service agreement includes software support for two years.

2. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION 271323

SECTION 271513 - COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Category 6 twisted pair cable.
2. Cable management system.
3. Identification products.

B. Related Requirements:
1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 DEFINITIONS

A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

B. EMI: Electromagnetic interference.

C. FTP: Shielded twisted pair.

D. F/FTP: Overall foil screened cable with foil screened twisted pair.

E. F/UTP: Overall foil screened cable with unscreened twisted pair.

F. IDC: Insulation displacement connector.

G. Jack: Also commonly called an "outlet," it is the fixed, female connector.

H. LAN: Local area network.

I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.

J. RCDD: Registered Communications Distribution Designer.

K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

M. S/FTP: Overall braid screened cable with foil screened twisted pair.

N. S/UTP: Overall braid screened cable with unscreened twisted pairs.

O. UTP: Unscreened (unshielded) twisted pair.

1.3 COPPER HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
3. Bridged taps and splices shall not be installed in the horizontal cabling.

B. A work area is approximately 100 sq. ft., and includes the components that extend from the equipment outlets to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.4 ACTION SUBMITTALS

A. Product Data:
1. Category 6 twisted pair cable.
2. Cable management system.
3. Identification products.

B. Shop Drawings: Reviewed and stamped by RCDD.

1. System Labeling Schedules:

    a. Electronic copy of labeling schedules, in software and format selected by Owner.
    b. Electronic copy of labeling schedules that are part of cabling and asset identification system of software.

2. Cabling administration Drawings and printouts.
3. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:

    a. Telecommunications rooms plans and elevations.
    b. Telecommunications pathways.
    c. Telecommunications system access points.
    d. Telecommunications grounding system.
    e. Telecommunications conductor drop locations.
    f. Typical telecommunications details.
    g. Mechanical, electrical, and plumbing systems.

C. Twisted pair cable testing plan.

D. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For RCDD, installation supervisor, and field inspector.

B. Product Certificates: For each type of product.

C. Source quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On USB media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings and cabling administration Drawings, cabling administration Drawings, and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. Communications, Plenum Rated:

    a. Type CMP complying with UL 1685 or Type CMP in listed plenum communications raceway.
    b. Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2. Communications, Non-Plenum Rated:

    a. Type CMR complying with UL 1666.
    b. Type CMP or Type CMR in listed plenum or riser communications raceway.
    c. Type CMP or Type CMR in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. RoHS compliant.

2.3 CATEGORY 6 TWISTED PAIR CABLE

A. Category 6 Twisted Pair Cable: Four-pair, balanced -twisted pair cable, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250 MHz.

B. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

C. Conductors: 100-ohm, 23 AWG solid copper.

D. Shielding/Screening: Unshielded twisted pairs (UTP).

E. Cable Rating: Plenum.

F. Jacket: Black thermoplastic.

2.4 TWISTED PAIR CABLE HARDWARE

A. Twisted Pair Cable Hardware: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. Match Owner's existing equipment.

C. General Requirements for Twisted Pair Cable Hardware:

1. Comply with the performance requirements of Category 6.
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables shall be terminated with connecting hardware of same category or higher.

D. Source Limitations: Obtain twisted pair cable hardware from same manufacturer as twisted pair cable, from single source.

E. Connecting Blocks:
1. 110-style IDC for Category 6.
2. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.

F. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

G. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:

a. Universal T568A and T568B wiring labels.
b. Labeling areas adjacent to conductors.
c. Replaceable connectors.
d. 24 or 48 ports.

2. Construction: 16-gauge steel and mountable on 19-inch equipment racks.
3. Number of Jacks per Field: One for each four-pair cable indicated.

H. Patch Cords: Factory-made, four-pair cables in 36-inch lengths; terminated with an eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

I. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Standard: Comply with TIA-568-C.2.
3. Marked to indicate transmission performance.

J. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Designed to snap-in to a patch panel or cover plate.
3. Standard: Comply with TIA-568-C.2.
4. Marked to indicate transmission performance.

K. Cover Plate:

1. Four port, vertical single gang cover plates designed to mount to single gang wall boxes.
2. Plastic Cover Plate: High-impact plastic. Coordinate color with Section 260533.16 "Boxes and Covers for Electrical Systems."
3. Metal Cover Plate: Nylon, complying with requirements in Section 260533.16 "Boxes and Covers for Electrical Systems."
4. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.

    a. Flush mounting jacks, positioning the cord at a 45-degree angle.

L. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.5 CABLE MANAGEMENT SYSTEM

A. Cable Management System: Computer-based cable management system, with integrated database and graphic capabilities.

B. Document physical characteristics by recording the network, TIA details, and connections between equipment and cable.

C. Information shall be presented in database view, schematic plans, or technical drawings.

1. Microsoft Visio Professional or AutoCAD drawing software shall be used as drawing and schematic plans software.

D. System shall interface with the following testing and recording devices:

1. Direct upload tests from circuit testing instrument into the personal computer.
2. Direct download circuit labeling into labeling printer.

2.6 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.7 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA-568-C.1.

C. Factory test twisted pair cables according to TIA-568-C.2.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Routing:

1. Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters. Conceal raceway and cables, except in unfinished spaces.

    a. Install plenum cable in environmental air spaces, including plenum ceilings.
    b. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."

2. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF PATHWAYS

A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings."

B. Comply with Section 260529 "Hangers and Supports for Electrical Systems."

C. Drawings indicate general arrangement of pathways and fittings.

3.3 INSTALLATION OF TWISTED PAIR HORIZONTAL CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:

1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
6. MUTOA shall not be used as a cross-connect point.
7. Consolidation points may be used only for making a direct connection to equipment outlets:

    a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
    b. Locate consolidation points for twisted pair cables at least 49 feet from communications equipment room.

8. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
9. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
10. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
11. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
12. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
13. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
14. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.

3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with "Firestopping Systems" Article in BISCI's "Telecommunications Distribution Methods Manual."

3.5 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."

C. Comply with TIA-607-B and NECA/BICSI-607.

D. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using the specified grounding electrode conductor.

E. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Paint and label colors for equipment identification shall comply with TIA-606-B, including optional identification requirements of this standard.

C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

E. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.

    a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
    b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

F. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by Architect.

B. Tests and Inspections:

1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

D. Nonconforming Work:

1. End-to-end cabling will be considered defective if it does not pass tests and inspections.
2. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services:

1. Engage factory-authorized service representative to supervise field tests and inspections.

3.8 MAINTENANCE

A. Software Service Agreement:

1. Technical Support: Beginning at Final Acceptance, verify that software service agreement includes software support for two years.
2. Upgrade Service: At Final Acceptance, update software to latest version. Install and program software upgrades that become available within two years from date of Final Acceptance. Verify that upgrading software includes operating system and new or revised licenses for using software.

    a. Upgrade Notice: No fewer than 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION 271513

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SECTION 283111 – EXISTING FIRE DETECTION AND ALARM SYSTEM EXTENSIONS AND NEW EMERGENCY VOICE COMMUNICATIONS SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Emergency Voice/Alarm Communication Control Panel.

B. Initiating devices.

C. Auxiliary devices.

D. Signaling appliances.

E. Fire alarm wire and cable.

F. Protective devices.

1.2 RELATED SECTIONS

A. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

B. Section 260533.13 – Conduits for Electrical Systems.

C. Section 260519 - Low-Voltage Electrical Power Conductors and Cables.

D. Section 260533.16 - Boxes and Covers for Electrical Systems.

E. Section 260553 - Identification for Electrical Systems.

1.3 REFERENCES

A. NFPA 70 - National Electrical Code.

B. NFPA 72 - National Fire Alarm Code.

C. NFPA 101 - Life Safety Code.

D. North Carolina State Building Code.

1.4 SYSTEM DESCRIPTION

This document provides for the furnishing, installation, and connection of equipment, accessories, and materials to provide a new Emergency Voice/Alarm Communications Control Panel to provide a complete and operational Fire Detection, Alarm and Emergency Voice/Alarm Communications System for the new existing facility and new Additions. The existing Simplex FACP shall remain and continue to serve the facility. Initiating devices in the new Additions shall be connected to the existing FACP for alarm, supervision and trouble in the new Addition and central station annunciation. Notification appliances in the new Addition and new notification appliances in the existing facility shall be driven by the new Emergency Voice/Alarm Communications Panel. The modifications and expansion of the system shall include, but not be limited to, alarm initiating devices, alarm notification appliances, auxiliary control devices,

annunciators, power supplies, speakers, amplifiers, voice/alarm communications equipment, wiring and all programming/reprogramming to function as required. The system shall comply with applicable provisions of the NC Building Code, NFPA 70 - National Electrical Code (NEC) and NFPA 72 - National Fire Alarm Code. The Contractor shall furnish all parts, materials, and labor customarily required or provided for a complete and operating system, in accordance with all requirements applicable, even if each needed item is not specifically shown or described in the project plans or specifications.

1.5 SUBMITTALS

A. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Submittals shall demonstrate compliance with technical requirements by reference to each subsection of this specification.

C. Product Data: Provide electrical characteristics and connection requirements, and provide mA draw for each device submitted and the listed minimum voltage required to operate. Panel submittal shall list voltage drop allowed for panel and for individual NAC circuits.

D. The fire alarm contractor shall submit complete Shop Drawings to the Architect/Engineer for review, prior to performing any work. They shall clearly demonstrate compliance with the Architect/Engineer’s Drawings and specifications, which have a System Response Matrix showing the fire alarm system's actions (outputs) required for each type of alarm, supervisory, and trouble signal. Any non-compliant features shall be fully described.

E. The submitted shop drawings shall show equipment, device identification numbers and locations, and connecting wiring of entire fire alarm system. Include wiring and riser diagrams. Wiring diagrams shall be based on the project floor plans, with devices and proposed conduit routing. The conductor composition for each conduit section shall be provided. The distance and route for each NAC (Notification Appliance Circuit) shall be shown. Riser diagrams shall show consecutive connections for all devices with addresses and candela and candela ratings. Provide detailed battery and communications amplifier(s) capacity calculations.

F. Architect/Engineer’s approval (with or without comments) of contractor’s Shop Drawings, samples, cut sheets, etc., is for general conformance with the contract documents and design concept. It shall not relieve the contractor of responsibility for full compliance with the project plans and specifications, EXCEPT for any specific non-compliant features for which the Architect/Engineer gives written authorization.

G. Installation Instructions: The contractor shall submit to the Architect/Engineer the manufacturer's detailed installation instruction for all duct mounted smoke detectors, flow switches, tamper switches, supervisory switches, and similar items which require mechanical installation.

H. Battery Calculations:

1. Include a copy of system battery sizing calculations with the shop drawing submittal to the Architect/Engineer. Use manufacturer's battery discharge curve to determine expected battery voltage after 60 hours of providing standby power. Then use calculated Notification Appliance Circuit current draw in the alarm mode to determine expected voltage drop at End of the Line Resistor (EOL), based on conductor resistance per manufacturer's data sheet or NEC.

2. Fire Alarm Vendor's calculations shall be submitted with the shop drawings, and prior to installation of equipment. In the submittal package identify Notification Appliance Circuits (NAC) current draws and voltage drops for each circuit. In no case shall the calculated voltage at any notification appliance fall below the minimum listed operating voltage for the devices used.
3. The voltage drop at EOL shall not exceed 14% of the expected battery voltage, after the required standby time plus alarm time. (Typically, for a 24 volt system, this limits the voltage drop from the battery to the EOL to 3 volts). Determine "worst case" voltage at far end of each NAC, by subtracting its calculated V-drop from the expected battery voltage. The result shall be no less than the minimum listed operating voltage for the alarm notification appliances used.
4. All of these calculations shall be placed on a dedicated sheet of as-built drawings, for future reference by fire alarm service technicians. NAC voltage drop is to be verified during system tests.

I. Maintenance Data: The contractor shall submit maintenance data and parts lists for each type of fire alarm equipment installed, including furnished specialties and accessories. This data, product data, and shop drawings shall be included in the maintenance manual.

J. Maintenance Contract: The contractor shall submit a quote for a maintenance contract to provide all maintenance, test, and repair described below and/or in accordance with NFPA-72, "Guide for Testing Protection Signaling Systems". Include also a quote for unscheduled maintenance/repair, including hourly rates for technicians trained on this equipment, and response travel costs. Submittals that do not identify all post contract maintenance costs shall not be accepted. Rates and costs shall be valid for the period of five (5) years after expiration of the guaranty. Maintenance and testing shall be on a semiannual basis or as required whichever is the most restrictive. A preventive maintenance schedule shall be provided by the Contractor that shall describe the protocol for preventive maintenance. The schedule shall include:

1. Semiannual systematic examinations, adjustment and cleaning of all detectors, manual fire alarm stations, control panels, power supplies, relays, water-flow switches and all accessories of the fire alarm system.
2. Semiannual testing of each circuit in the fire alarm system.
3. Semiannual testing of each smoke detector in accordance with the requirements of NFPA 72.

K. Certifications: The installing contractor's technicians shall hold current (within previous 24 months) certifications issued by the manufacturer. These certifications shall be submitted to the Architect/Engineer prior to installation showing name, photo identification, date of training and date of certification.

L. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and commissioning of products.

1.6 QUALIFICATIONS

Not used. The vendor is Johnson Controls/Simplex.

1.7 REGULATORY REQUIREMENTS

A. Equipment and installation shall conform to requirements of NFPA 70, NFPA 72, NFPA 101, North Carolina State Building Code and shall be FM approved.

B. Furnish products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

The existing system is Simplex. All additions and modifications to the existing system must be performed by Johnson Controls/Simplex.
The existing FACP shall remain and be programmed to include initiating devices in the new Addition. A New Emergency Voice/Alarm Communication Control Panel shall be installed adjacent to the existing fire alarm control panel and interfaced to the existing FACP. The modified system will continue to operate as currently configured. Requirements stated herein are not intended to contradict the existing system's current operation and features. All new components and materials shall match the existing system.

2.2 ALARM APPLIANCES

A. Strobe Lights shall be located as shown on the Drawings. Match existing. Strobe lights indicated for use exterior to the building shall be mounted at the indicated elevation and listed for use in wet locations. Strobe lights shall operate with synchronized flash output and have the following specifications:
   1. Voltage: Strobe lights shall operate on 24 VDC nominal.
   2. Maximum pulse duration: 2/10ths of one second.
   3. Strobe intensity and flash rate: Shall meet minimum requirements of UL 1971. Provide strobe lights with minimum intensity Candela (Cd) rating of 15/75 Cd, or greater if such is indicated adjacent to the device symbol on the Drawings.

B. Emergency Voice/Alarm Communications System and Audible Devices:
   1. Zone Amplifiers: Provide zone amplifiers, control equipment, power supplies, etc. in cabinet(s) as required to maintain required sound levels in all areas of the new Additions.
   2. Speakers: Speakers, where specified, shall have audible sound with taps at 1/4 watt, 1/2 watt, 1 watt, 2 watts and shall operate at 70.7V. Provide round grilles and back boxes for all speakers. Grilles shall be provided with a finish color matching the surrounding ceiling finish color. Provide rated boxes for use in rated ceilings. Speakers shall be tapped at 1 watt for design purposes. See additional requirements for Programmable Electronic Sounders.
   3. Horns: Where provided, shall provide average ambient sound level of dBA as listed in the NEPA 72.
   4. Audible/Visual Combination Devices (Horn/Strobes, Speaker/Strobes and Programmable Electronic Sounders) shall comply with all applicable requirements for Horns, Speakers, Programmable Electronic Sounders and Strobe Lights.
   5. Bells shall be 10" diameter vibrating type located as shown on the Drawings; bells located outdoors shall be listed for use in wet locations. Bells shall have the following specifications: Voltage: Bells shall operate on 24 VDC nominal.

2.3 INITIATING DEVICES: Match existing.

2.4 AUXILIARY DEVICES

A. Addressable Dry Contact Monitor Module: Match existing.
   1. Monitor modules shall be installed as required by the system configuration. All required monitor modules may not be shown on the Drawings. Indication of Operation: Unless otherwise indicated on the Drawings an LED shall be provided that shall flash under normal conditions, indicating that the Monitor Module is operational and in regular communication with the control panel.

B. Addressable Control Module: Match existing.

C. Isolator Module: Math existing.

D. Sprinkler and Standpipe Valve Supervisory Switch:

1. Supervisory switch mechanisms shall be contained in weatherproof housings that shall provide a 3/4 inch tapped conduit entrance and shall incorporate the necessary facilities for attachment to the valves. Switch housing shall be finished in red baked enamel.
2. Mounting: Mount switch so as not to interfere with the normal operation of the valve and adjust to operate within two revolutions toward the closed position of the valve control, or when the stem has moved no more than one-fifth of the distance from its normal position.

E. Serially Connected Remote Annunciators: Provide a remote annunciator in the new Addition as shown on the Drawings.

1. Annunciators shall communicate with the fire alarm control panel via an EIA-485 communications loop (four-wire) and shall individually annunciate all zones in the system. System zones shall be as indicated on the Drawings.
2. Annunciator Indicators: The annunciator shall provide a red Alarm LED per zone, and a yellow Trouble LED per zone. The annunciator shall also have an "ON-LINE" LED, local piezo sounder, local acknowledge/lamp test switch, and custom zone/function identification labels. Annunciator switches may be used for System control such as, Global Acknowledge, Global Signal Silence, and Global System Reset. All annunciator switches and indicators shall be software programmable.
3. LCD Alphanumeric Display Annunciator: The Alphanumeric Display Annunciator shall be a supervised, remotely located back-lit LCD display containing a minimum of eighty (80) characters for alarm annunciation in clear English text. The LCD Annunciator shall display all alarms and trouble conditions in the system.
4. System Capacity: The system shall allow a minimum of four LCD annunciators. In addition to annunciation functions, each LCD annunciator shall be capable of the following software programmed system functions: Acknowledge, Signal Silence and Reset.
5. Connections: The annunciator shall connect to a two-wire EIA-485 interface. The two-wire connection shall be capable operation at distances of 6,000 feet. Provide interface to fiber optic cable systems and/or repeater units where such are indicated on the Drawings.
6. Remote Annunciator Indicator Lights (RAIL): RAILs shall be provided with a key type switch for testing of the annunciated device. RAILs shall operate on 24 VDC nominal.

F. Door Hold-Open Magnets:

1. Door hold open magnets shall be suitable for mounting in a single gang electrical device box. Door hold open magnets shall be furnished with keepers, door chains, and other accessories as required to properly hold open doors as indicated on the Drawings. Holding force of the magnet shall be appropriate for the door to be held open. Door hold open magnets shall operate in a fail safe manner, i.e., the door shall release in event of a failure of voltage to the device.
2. Power Source: Door hold open magnets shall be configured to operate from a nominal 24 VDC system as supplied by the FACP or other power supply listed for the purpose. All hold open magnet supply sources, whether a part of the FACP or whether derived from a separate power supply, shall be supervised. Door hold open magnet circuits which use step-down transformers, 120 VAC, or local relays are not permitted. Door shall close after 60 seconds of the power loss.

G. Wiring: Match existing.

2.6 EMERGENCY VOICE/ALARM COMMUNICATION SYSTEM

The system shall have Emergency Voice/Alarm Communication capability of one-way voice public address communications. The systems shall be installed for maximum survivability having separated dual risers.

A. One-way Public Address System:
   1. The one-way public address risers shall feed approximately half the speakers on each floor from each riser.
   2. The system shall be dual channel, permitting the transmission of an evacuation signal to one or more zones and simultaneous manual voice paging to other zones, selectively and in combination.
   3. Each floor, stairway, elevator bank, and assembly space (greater than 300 people) shall be a separate communication zone. Speakers are to be spaced to provide a nominal sound level of at least 90 dBA measured at 10 feet. Speaker circuits shall be electrically supervised for open and/or short circuit conditions, if a short circuit exists on a speaker circuit, it shall not be possible to activate that circuit. Speaker circuits shall be either 25 V rms or with field selectable output taps from 0.5 to 2.0 watts, and shall have 20% spare capacity for future expansion or increased power output requirements. Frequency response shall be a minimum of 400 Hz to 400 Hz. The back of each speaker shall be sealed to protect the speaker cone from damage and/or dust.
   4. The normal audio amplifier power shall be a minimum of 120% of the system design load, per channel. The calculation shall use the amplifier's continuous two-tone output rating and the designed power setting for each individual speaker. A copy of this calculation shall be included with the shop drawing submittal to the Architect/Engineer and shall also be included in the record drawings (reference Paragraph 3.2 G below).
   5. At least one backup amplifier shall be provided for each channel, equal in power to the largest primary amplifier. For systems with distributed amplifiers, there shall be provided one backup at each transponder location. Failure of any amplifier shall automatically result in the defective unit being switched off-line and replaced with the backup. Audio amplifiers and tone generating equipment shall be electrically supervised for normal and abnormal conditions.
   6. The audible emergency evacuation signal shall comply with Paragraph 2.5A above and, additionally shall provide for non-evacuation and other notification signals, including recorded voice messages for specific emergency situations.
   7. The digital audio circuits shall be wired with twisted pair copper conductors (AWG 18 minimum) in jacketed cable, or with fiber optic cable. Analog audio circuits shall be wired with AWG 18 minimum twisted pair copper conductors in shielded cable, Belden 8790, West Penn 293 or equal. Cable jacket color is to be gray, with red (+) and black (-) conductor insulation. Shielded cable shall be supplied with a shield that is continuously connected from the amplifiers to the end of the line. The shield splice shall be taped to each speaker to insulate from ground and a single point ground shall be used for the shield at the amplifier or control unit unless prohibited by the system manufacturer.

B. The system shall have sufficient capacity for the new Additions and the existing facility. The existing facility notification appliances will be changed to be compatible with the new Emergency Voice/Alarm Communication System.

2.5 TERMINAL CABINETS

Terminal cabinets shall be sheet steel, hinged cover type not less than 10" x 16" x 10" deep. Cabinets shall conform to Specs Section 260534 and shall be labeled in accordance with Specs Section 260553.

PART 3 - EXECUTION

3.1 FIRE ALARM SYSTEM

A. The new fire alarm system expansion into the Additions shall be new and furnished with a warranty (parts & labor) of at least one year from the date of final inspection and/or acceptance by the Owner. Equipment, initiating devices, and alarm appliances shall be arranged and the annunciator zones shall be configured as described by the Architect/Engineer's written specifications.

B. All equipment supplied shall be specifically listed for its intended use and shall be installed in accordance with the manufacture's recommendations. The contractor shall consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation. Contractor shall refer to the Riser/Connection diagram for all specific system installation/termination/wiring data.

C. All system components shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load. Adhesives are not permitted to mount fire alarm system components to building surfaces or structure.

D. Set spot-type smoke detector sensitivities to normal/medium, unless directed otherwise by the Architect/Engineer or Owner's rep. High sensitivity may be appropriate in relatively benign, clean environments such as art museums and libraries, to improve system response time without causing nuisance alarms.

E. Print a complete System Status and Programming Report after the above steps have been done. This shall include the program settings for each alarm initiating device and the current sensitivity of each analog addressable smoke detector.

3.2 FIRE ALARM CONTROL EQUIPMENT INSTALLATION

A. The technician who makes final connections and programs the FACP is the "installer".

B. Notification Appliance Circuit booster power supplies shall be individually monitored by the FACP and protected by a smoke detector per NFPA 72. They shall not be located above a ceiling, or in non-conditioned space. A 24vdc power circuit serving addressable control relays shall also be monitored for integrity.

C. Basic operating instructions shall be framed and permanently mounted at the FACP. (If the Owner concurs, they may instead be affixed to the inside of the FACP's door.) In addition, the NFPA 72 "Record of Completion" shall either be kept at/in the FACP, or its location shall be permanently indicated there by an engraved label.

D. Provide an engraved label inside the FACP identifying its 120vac power source, as follows: Panelboard location, panelboard identification, and branch circuit number.

E. Alarm notification appliances (audible and visible) shall comply with NFPA 72, the North Carolina Building Code, and ANSI 117 criteria for intensity and placement. The audible evacuation signal shall be the ANSI S3.41 three-pulse temporal pattern. All strobe lights installed in a single space shall be synchronized. Strobe synchronization with adjoining existing spaces shall comply with NFPA 72 requirements.

3.3 ADDRESSABLE INTERFACE MODULES (Control and Monitor Modules)

A. Addressable interface modules (used to monitor all contact type initiating devices) shall be located in conditioned space, unless they are tested, listed, and marked for continuous duty across the range of temperatures and humidity expected at their installed location.

B. One module may serve as many as 3 sprinkler system valve supervisory switches in a single space; otherwise provide one module per switch.

C. One module may serve as many as 6 heat detectors in a single space

D. Sprinkler system supervisory circuits for monitoring valve position, air pressure, water temperature, pump status, etc., shall cause distinct audible and visible indications at the FACP. The audible supervisory signal shall either be a 4" diameter bell or a pulsing piezo-electric alarm. Provide the following engraved label adjacent to the bell/alarm: "SPRINKLER STATUS ABNORMAL". If only valve position is supervised, provide an engraved label reading: "SPRINKLER VALVE CLOSED"

3.4 SURGE PROTECTION

A. For each AC power circuit that interfaces with fire alarm equipment install an AC suppressor in a listed enclosure near the electrical panelboard, and trim excess lead lengths. Wind small coil in the branch circuit conductor just downstream of the suppressor connection. Coil to be 5 to 10 turns, about 1" diameter, and securely tie-wrapped. This series impedance shall improve the effectiveness of the suppressor in clipping fast rise time voltage transients.

B. On DC Circuits Extending Outside Building: Install the surge arrestor in a labeled enclosure near the point of entry to or exit from each building.

3.5 AC POWER

A. Switching to emergency power during alarm shall not cause signal drop-out. Batteries shall meet the appropriate NFPA capacity requirements, with a 25% safety factor. This requirement is in effect even if generator power is supplied to the Fire Alarm Control Panel.

B. The branch circuit breaker(s) supplying the system shall be physically protected by panelboard lock or handle lock and each shall be identified with a 1/4" permanent red dot applied to handle or exposed body area.

C. Provide an engraved label at each fire alarm system control unit, system sub-panel or data gathering panel, supplementary notification appliance (SNAC) panel, digital alarm communicator, etc.

3.6 CONDUIT AND WIRING

A. The exterior of all junction boxes containing fire alarm conductors shall be painted red; box interiors shall not be painted. Box covers for junction boxes containing fire alarm conductors shall be painted red on both sides.

B. Box covers shall be labeled to indicate the circuit(s) or function of the conductors contained therein. Labels shall be neatly applied black lettering on a clear background. Handwritten labels or labels made from embossed tape are not acceptable.

C. All fire alarm system wiring shall be in metal conduit or surface metal raceway. All fire alarm system raceway, couplers, and connectors shall meet the performance and installation requirements of Electrical Specification Section "RACEWAYS".

D. If cable size and the requirement to maintain a Class "A" loop on all Signaling Line Circuits cause conduit fill to exceed specified maximums for the 1/2" size; 3/4" raceway shall be used.

E. All conduits that penetrate outside walls from air conditioned space shall have internal sealing (duct-seal), to prevent condensation from infiltrating humid air.

F. All wiring shall be color coded and match the existing color coding scheme installed. All the circuits in the system shall be wired with AWG 14, minimum, stranded copper, THHN/THWN conductor, installed in metallic conduits.

G. To minimize wiring fault impact, isolation modules shall be provided in all of the locations listed below. If ceiling height ≤10 feet, isolator base type initiating devices are permitted to be used to satisfy any or all of the following:

1. In or immediately adjacent to the FACP, at each end of the addressable loop. These two isolators shall be in the same room and within 15 feet of the FACP.
2. After each 20 initiating devices and control points on the addressable loop, or a lesser number where recommended by the manufacturer. (Check instructions.)
3. For loops with 20 devices and control points, install an isolator at the approximate middle of the loop (in addition to those at the FACP).
4. Near the point any addressable circuit extends outside the building, except for those attached to the building exterior walls and well sheltered by walkways.
5. For loops covering more than one floor, install isolator at terminal cabinet on each floor (with additional isolators on any floor with over 20 addresses).
6. Each isolation module shall be clearly labeled, readily accessible for convenient inspection (not above a lay-in ceiling), and shown on as-built drawings.

H. Detection or alarm circuits shall not be included in raceways containing AC power or AC control wiring. Within the FACP, any 120 VAC control wiring or other circuits with an externally supplied AC/DC voltage above the nominal 24 VDC system power shall be properly separated from other circuits and the enclosure shall have an appropriate warning label to alert service personnel to the potential hazard.

I. There shall be no splices in the system other than at device terminal blocks, or on terminal blocks in cabinets. "Wire nuts" and crimp splices shall not be permitted. Permanent wire markers shall be used to identify all connections at the FACP and other control equipment, at power supplies, and in terminal cabinets. All terminal block screws shall have pressure wire connectors of the self lifting or box-lug type.

J. All wiring shall be checked for grounds, opens, and shorts, prior to termination at panels and installation of detector heads. The minimum resistance to ground or between any two conductors shall be ten (10) megohms, as verified with a megger. Provide advance notice to the Architect/Engineer of these tests.

K. The system shall be electrically supervised for open or (+/-) ground fault conditions in SLC, alarm circuits, and control circuits. Removal of any detection device, alarm appliance, plug-in relay, system module, or standby battery connection shall also result in a trouble signal. Fire alarm signal shall override trouble signals, but any pre-alarm trouble signal shall reappear when the panel is reset.

3.7 NOTIFICATION DEVICES

A. Both audible and visible alarm signals shall be provided. Visible signals shall be the strobe (flash discharge) type, with white or clear lens, and shall comply with current ADA requirements for intensity and placement.

B. End of Line (EOL) Device: The end of line device shall be installed in accessible terminal cabinets or dedicated accessible boxes, to facilitate testing and maintenance.

3.8 DETECTORS

A. When installed in a room, detectors shall be oriented so their alarm light is visible from the nearest door to the corridor, unless Remote Alarm Indicator Light (RAIL) equipped.

B. Spot-type smoke detectors shall secure the head to the base thru the built-in locking device. For detector mounted within 12 feet of the floor, activate this lock after the system has been inspected and given final acceptance.

C. Unless suitably protected against dust, paint, etc., spot type smoke detectors shall not be installed until the final construction clean-up has been completed. In the event of contamination during construction, the detectors shall be replaced by the contractor at no additional cost to the Owner. Covers supplied with smoke detector heads do not provide protection against heavy construction dust, spray painting, etc., and shall not be used for that purpose. They are suitable only during final, minor cleanup or touchup operations.

D. A detector installed where accidental damage or deliberate abuse is expected shall be provided with a guard that is listed for use with it and is acceptable to the AHJ.

E. Identification of individual detectors is required. Assign each a unique number matching the existing scheme.

F. Duct Mounted Smoke Detectors:

1. All air duct/plenum detectors shall have a Remote Alarm Indicator Lamp (RAIL) installed in the nearest corridor or public area and identified by an engraved label affixed to the wall or ceiling. Where detectors are in close proximity, RAIL devices shall be grouped as shown on the Drawings. Duct smoke detectors are permitted to be installed only inside an air duct. It is not appropriate to mount them in front of a return air opening. Duct detectors shall also be installed in a manner that provides suitable, convenient access for required periodic cleaning and calibration. The numbers of detectors per duct shall be per NFPA 72 requirements based on the size of the air duct, air duct configuration, air speed, and duct manufacture’s installation requirements.
2. Each duct detector installation shall have a hinged or latched duct access panel, 12x12 inches minimum, for sampling tube inspection and cleaning. Indicate airflow direction on the duct, adjacent to the detector, using stencil or permanent decal.
3. Duct detector sampling tubes shall extend the full width of the duct. Those over 36 inches long shall be provided with far end support for stability. The preferred method for providing support is to extend the intake tube through the far side of the duct, seal around the tube where it penetrates the duct wall, and plug the end with a rubber stopper. This facilitates visual inspection, intake tube cleaning, and injection of smoke or equivalent aerosol for testing the detector.
4. Duct smoke detector mounting position and air sampling tube orientation are critical for proper operation. The Manufacturer's detailed installation instructions shall be followed. The contractor shall mark the direction of air flow on the duct at each duct detector location.
5. Unless the AHJ requires otherwise, all duct smoke detectors shall be programmed for fire alarm (not for supervisory annunciation).

3.9 PRINTER

Existing.

3.10 AIR HANDLER UNIT (AHU) SHUTDOWN

A. A supervised "AHU Shutdown Defeat" switch shall be provided in/adjacent to the FACP or as a key-operated function in the Remote Annunciator (if provided). If the FAA option is utilized, provide an informative engraved label at the FACP about this function. The switch shall cause a system "trouble" indication when it's placed in the off-normal ("Shutdown Defeated") position. This is to provide the Owner with a convenient means to temporarily resume HVAC operation in the event an unwanted alarm shall not clear, prior to arrival of the fire alarm service technician.

B. If the system includes AHU shutdown or smoke removal startup, silencing the alarm (without resetting) shall not reverse the shutdown. A supervised "AHU Shutdown Defeat" switch shall be provided in the FACP. The switch shall be labeled and its "Normal" position indicated. Provide supervised Hand-Off-Auto switch(es) at the FACP for any building smoke control equipment (pressurization or exhaust fans).

3.11 ANNUNCIATOR

A. Provide a LED-type "zone" annunciator at the new Addition in the location shown or a location acceptable to the AHJ. As a minimum, this annunciator shall indicate the specific type of alarm or supervisory signal (smoke detector, water-flow, sprinkler valve closed, etc.), for groups of addressable devices. The area ("zone") that is represented by each LED shall not exceed 1 floor or 22,500 square feet, and shall not cross building fire walls or smoke compartments.

1. Systems in 1 or 2-story buildings, which have 30 or fewer initiating devices, are permitted to omit the LED-type "zone" annunciator.
2. Systems with a Graphic Annunciator (GA) are permitted to omit the LED-type "zone" annunciator.
3. The LED annunciator is permitted to be omitted if the FACP has a multi-line display that automatically defaults to displaying the first alarm, plus the first 3 (minimum) water-flow alarms and the last alarm. This is permitted to be done using 2 automatically alternating screens. If there is no sprinkler system, program the FACP to show the first 4 alarms plus the last alarm received.

3.12 ALARM VERIFICATION FOR SMOKE DETECTORS

A. The fire alarm system shall be equipped with Alarm Verification.

B. System shall provide as a feature an alternate signal processing algorithm to verify the presence of smoke. The algorithm shall be selectable during system programming. The total effective delay created by the verification algorithm shall not exceed 60 seconds.

3.13 AUTOMATIC SMOKE DOOR AND AUTOMATIC LOCK REQUIREMENTS

A. Wall-mounted magnetic door holders and separate heavy-duty closers shall be used, instead of combination door control units. The electromagnets shall be controlled by the building's smoke detection system FACP. Individual smoke detector auxiliary contacts shall not be used to release door holders.

B. Automatic door locks controlled by the system shall be either fail safe magnetic locks or fail-safe electro-mechanical with reverse bevel dead bolts.

C. All locked protected doors shall immediately unlock upon fire alarm, loss of AC power, disablement of the fire alarm system (defined as loss of 24 VDC power) or upon manual operation of an unlock switch at a constantly attended location.

3.14 SPRINKLER SYSTEM MONITORING

A. The following sprinkler system alarm and supervisory functions shall be provided as a part of the fire alarm system:

1. Water-flow alarm, by sprinkler zone (not to exceed one floor).
2. Supervision of each control valve.

B. Sprinkler supervisory monitoring of flow switches, tamper switches, and similar functions shall be accomplished with a separate system address for each activity monitored.

3.15 FIRE ALARM SYSTEM INSTALLATION AND CONFIGURATION

A. Supervision required: The connection between individual addressable modules and their contact type initiating device(s) shall be supervised. Where indicated on the Drawings, a Graphic Annunciator (GA) with separate Light Emitting Diodes (LED) indication for each alarm and supervisory signal initiating device shall be included. Multiple initiating devices of the same type within a single room may be permitted to share a common LED. The GA shall show all major building features such as corridors, elevators, stairs, exits, and "YOU ARE HERE". GA layout shall be submitted for approval.

B. Graphic Chart shall be mounted behind Plexiglass and secured to surface. Mounting shall be such that charts cannot be removed without a flat head screw driver.

C. Floor Plans with Device Numbers: A copy of the floor plans shall be provided in the control panel. A separate sheet shall be provided for each floor. Plans shall be reduced in size from engineering plans in order to fit on 11 x 14 sheets. All device addresses shall be clearly labeled on plans. Indicate locations of all cabinets, modules and end of line device. Plans shall be bound in book form. Sheets shall be laminated. Provide legend for symbols. Provide holder for plan book in panel or in a locked box adjacent to panel keyed to match panel. Provide label for box and book.

D. Loop 1 shall be assigned to the first floor devices and loop number shall increase with floor number. Device numbering starts in the same location on each floor and increase accordingly as circuit location increases.

3.16 FIRE AND LIFE SAFETY CRITERIA FOR DOORS CONTROLLED BY FIRE ALARM SYSTEM

A. Exit or exit access doors that are locked to delay egress, in accordance with the NC Building Code:

1. These doors shall immediately unlock upon any fire alarm signal, loss of building AC power, disablement of the fire alarm system (defined as loss of its 24vdc power), or upon manual operation of an unlock switch at a constantly attended location.
2. Where installed on smoke or fire doors, power failure shall cause these mechanisms to default to the egress mode with normal mechanical latching; this is to assure the smoke or fire doors continue to perform their vital function in a power failure situation, instead of swinging open and allowing the passage of smoke and fire between compartments.
3. Smoke doors are permitted to be held open by 24vdc wall/floor-mounted magnets powered by the FACP, and released upon alarm. The resulting current drain shall be included in the standby battery calculations or the system shall be programmed to drop the door hold-open magnet load 60 seconds after the loss of 120vac power

B. Contact the AHJ for guidance on programming the fire alarm system to determine which fire alarm initiation devices should cause release of these doors. The customary setup is to have this done for selected smoke detector and/or water-flow alarm in adjacent spaces, rather than upon general alarm, to minimize the potential disruption of possible nuisance alarms in remote parts of the

building. The FACP should have an appropriate information placard regarding this function, to avoid nuisance drops during routine system maintenance operations.

3.17 SYSTEM DOCUMENTATION, TRAINING AND MAINTENANCE

A. Maintenance: The manufacturer, or authorized distributor, shall maintain software version records on the system installed. The system software shall be upgraded free of any charge if a new VER is released during the warranty period. For new VER to correct operating problems, free upgrade shall apply during the entire life of the system.

B. System Report in addition to the Shop Drawing submittal described elsewhere, the fire alarm system contractor shall provide the Architect/Engineer two bound copies of the following technical information, for transmittal to the owner:

1. As-Built wiring diagram showing all loop numbers and device addresses, plus terminal numbers where they connect to control equipment.
2. As-built wiring and conduit layout diagrams, including wire color code and/or label numbers, and showing all interconnections in the system.
3. Electronic circuit diagrams of all control panels, modules, annunciators, communications panels, etc.
4. Manufacturer's detailed maintenance requirement.
5. Technical literature on all control equipment, isolation modules, power supplies, batteries, detectors, manual stations, alarm/supervisory signal initiating devices, alarm notification appliances, relays, remote alarm transmission means, etc.
6. The as-built "calculations" sheet.

C. Electronic archive: Complete configuration data (site-specific programming) for the system shall be stored on electronic media and archived by the fire alarm system manufacturer or authorized distributor. A diskette or CD copy of this data shall be submitted to the Architect/Engineer for transmission to the owner on the day the system is commissioned. The contractor shall provide the owner with one copy of the following:

1. All software required, both for the installed fire alarm system and personal computer (PC) necessary to access the fire alarm system for trouble shooting, programming, modifications, monitoring, de-bugging, or similar functions, (if Owner does not have the needed PC to check the system).
2. Complete documentation for all software for both the installed fire alarm system and for any interface PC software necessary for system functions as described above.
3. Framed floor plans, mounted at the FACP. Plans shall show all system devices with the unique device identification numbers indicated adjacent to each device. The identification numbers shall match those represented in the as-built drawings and those reported at the FACP and the LCD annunciator.
4. Interconnection cable where such is required to connect the fire alarm system to a PC; (if Owner does not have the needed PC to check the system).

D. Training; the manufacturer's authorized representative shall instruct the owner's designated employees in operation of the system, and in all required periodic maintenance. Two copies of a written, bound summary shall be provided, for future reference.

1. Some facilities maintain their own systems and require more in-depth training. Check to verify needs and requirements.
2. Scheduling of training shall be arranged to meet the Owner’s schedule. Additional training shall be available at a cost to be mutually agreed upon by the Owner and the Contractor.
3. Training shall be in the Owner’s provided classroom.
4. The training may not be waived, deleted or reduced in the number of hours required.
5. Training shall cover as minimum the following topics:

a. Preventive maintenance service techniques and schedules, including historical data trending of alarm and trouble records.

b. Overall system concepts, capabilities, and functions. Training shall be in depth, so that the owner shall be able to take any device out of service and return any device to service without need of Manufacture's approval or assistance.

c. Explanation of all control functions, including training to program and operate the system software.

d. Methods and means of troubleshooting and replacement of all field wiring devices.

e. Methods and procedures for troubleshooting the main fire alarm control panel, including field peripheral devices as to programming, bussing systems, internal panel and unit wiring, circuitry and interconnections.

f. Manuals, drawings, and technical documentation. Actual system software used for training shall be provided in digital form and shall be left with the Owner at the completion of training for the Owner's use in the future.

g. The owner shall be trained to perform all NFPA 72 required maintenance. The training shall include both demonstration and supervision of a "hands-on" replacement of heads. Panel modifications required to take detector heads out of service and return them to service shall be "hands-on" training session. The training shall be in a minimum of two 4-hour sessions provided on separate days. The schedule shall be coordinated with the owner. A written competency test shall be submitted to the Architect/Engineer and to the owner as a sample prior to using the written competency test at the site. A written description of a hands-on test shall be provided to the Architect/Engineer and owner for review prior to using the test at the site. As a minimum the following tests shall occur during certification of the owner's employee:

1) Three smoke heads shall be taken offline at the panel and removed physically.
2) Three smoke heads shall be reinstalled and returned to service at the fire alarm panel.
3) The vendor shall provide three dirty smoke detector heads to be installed at various positions in the building. The owner shall print a sensitivity report and the employees shall find the "dirty" smoke detector heads by reviewing the sensitivity report.
4) A ground fault and an isolation problem shall be introduced by the vendor into the system. The employees shall then find the ground fault and the isolation problem.
5) An NFPA 72 "Record of Completion" form shall be provided and the employees shall fill out the forms which shall be checked by the vendor for proper use of the form.
6) The written testing for how to perform services on a panel shall be given during the last 4 hour session with the employees.
7) The vendors shall witness the owner's "trained" employees, train other employees and correct any mistakes made during the training session. This is expected to occur during the 2nd four hour session.

3.18 SYSTEM TESTING AND CERTIFICATION

A. Upon completion of the installation the Contractor and the Manufacturer's authorized installer together shall conduct a 100% performance test of each and every alarm initiating device for proper response. The system shall operate for 48 hours prior to start of test. The Contractor shall be present for the full 100% test.

B. The A/E and owner shall be given 7 days advance notice of the tests. All Audio Visual Device Testing shall be scheduled with the owner.

C. 100% Test: The manufacturer or authorized distributor (by definition, "installer") shall 100% test all site-specific software functions for the system and then provide a detailed report or check list showing the system's operational matrix. This documentation shall be part of the "System Status and Programming Report".

1. Upon completion of the installation and its programming, the installer's technician shall test every alarm initiating device for proper response and indication, and all alarm notification appliances for effectiveness. Also, in coordination with the other building system contractors, all other system functions shall be verified, including (where applicable) elevator capture and the control of HVAC systems, door locks, pressurization fans, fire or smoke doors/dampers/shutters, etc. The Architect/Engineer shall be notified in advance of these 100% tests, to permit witnessing them if desired.
2. If AHU shutdown occurs for any alarm, then the matrix would indicate the specific control relay(s) for that function being commanded to operate for alarm from any initiating device. If a rolling steel fire door is to drop only upon water-flow alarm from its sprinkler zone, or upon any two spot smoke detectors in adjacent spaces being simultaneously in alarm, the matrix would show the door's control relay activating upon alarm from the applicable water-flow switch(es), or from any two smoke detectors in the selected spaces (AND gate)
3. The Digital communicator shall be on-line tested for proper communication to the receiving station.
4. All supervised circuits shall also be tested to verify proper supervision. (Control circuits and remote annunciation lines are among those required to be supervised.)
5. All testing described above shall be repeated in the event that subsequent software or wiring modifications are determined necessary to meet the requirements of the contract documents. Such re-testing shall be included as part of the base bid and provided at no additional cost to the Owner.
6. Test Documentation: The installer shall fill out and submit the following documentation to the owner, through the Architect/Engineer, prior to the AHJ's system acceptance inspection:

    a. Written verification that this 100% system test was done with copy of print out generated during test.
    b. The NFPA 72, "Record of Completion" Form. Use this form (no substitutes) to detail the system installation and also to certify that: (a.) It was done per Code, and (b.) The Code-required 100% test was performed. The fire alarm installer (manufacturer or authorized distributor's technician) shall sign this form. If a representative of the AHJ, owner, or Architect/Engineer witnesses the tests, in whole or in part, they shall also sign the form to signify that fact only (annotating the form as needed to clarify their limited role).
    c. For buildings with a smoke control or smoke purge system, an HVAC balance report, in the smoke control / smoke purge mode.
    d. The System Status and Programming Report described in NFPA 72. This shall be generated on the day of the system acceptance inspection and shall include the measured sensitivity of each smoke detector.
    e. The purpose of doing Item (d) on the day of the inspection is to assure detector sensitivity has not been affected by construction dust. Prudent contractors shall have taken measures to prevent detector contamination during construction, and shall also have had the system do a detector sensitivity test and printout prior to the day of the inspection, to make certain all devices are properly programmed and operating within their limits.
7. After completion of the 100% system test and submission of documentation as described above the installer is to request the Architect/Engineer to set up an inspection. The system shall operate for at least two days prior to this inspection. The responding Fire Department shall be notified of this, for pre-fire planning purposes. On local government projects, local fire authorities may also want to participate in system acceptance inspections. However,

for State-owned property they have no inspection jurisdiction and, if present, are only to observe.

3.19 PRE-FINAL AND FINAL INSPECTION

A. Pre-Final Inspection: At the Owner's request and after passing the Designer's pre-final inspection, the Contractor and Manufacturer's authorized installer shall conduct system test in the presence of the Owner and the Designer.

B. Final Inspection: The fire alarm system shall be inspected, with portions of it functionally tested. This shall normally include the use of appropriate means to simulate smoke for testing detectors, as well as functionally testing the system interface with building controls, fire extinguishing systems and any off-premises supervising station. Operation of any smoke removal system shall be checked as instructed by the AHJ. This statistical (sampling) inspection is intended to assure that the contractor has properly installed the system and performed the 100% operational test as required by NFPA 72. The electrical contractor shall provide two-way radios, ladders, and any other materials needed for testing the system, including a suitable smoke source.

C. The test shall be conducted entirely by the Contractor. A copy of the final database software shall be presented to the Owner before this test. The software shall be loaded from these disks into the system in the presence of the Owner. The review shall then be conducted using this software. Any deficiencies shall be recorded and corrected. After the items have been corrected, the system shall be tested again.

1. In the event of malfunctions or excessive nuisance alarms, the Contractor shall take prompt corrective action. The Owner may require a repeat of the Contractor's 100% system test, or other inspections.
2. Test Report: Upon successful completion of the Inspection and after the correction of all efficiencies, the manufacturer's authorized representative shall issue a test report to the Architect/Engineer and Owner, detailing and certifying the test.
3. System Acceptance: After successful completion of the Final Inspection and recommendation of the Architect/Engineer, the system shall be accepted by the Owner. At this time the warranty period begins.

3.20 REACCEPTANCE INSPECTION

As the new Building Addition fire alarm system will be connected to the existing Building fire alarm system, test and recertify the existing Building fire alarm system per NFPA 7214.1 and Annex A 14.4. This testing shall include verification of all life safety functions of the system including elevator capture, AHU shutdown, door control, smoke control, emergency voice/alarm communications, etc. This does NOT mean to field verify the actual control of specific devices. This test verifies fire alarm circuits, programming, relays, etc. operate as intended.

END OF SECTION 283111

SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and removing site utilities.
7. Temporary erosion- and sedimentation-control measures.

B. Related Sections to Reference:

1. Section 312000 "Earth Moving".
2. Section 312500 "Soil Erosion and Sedimentation Control".
3. Section 313116 "Termite Control".
4. Section 331000 "Water Utility Distribution Piping".
5. Section 334101 "Sanitary Utility Sewerage Piping".
6. Section 334000 "Stormwater Drainage System".

1.3 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

D. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.

E. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and as indicated on Drawings.

F. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

1. Use sufficiently detailed photographs or videotape.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at the project site.

1.7 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect.

C. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises.

D. Utility Locator Service: Notify utility locator service, NC One Call Center for area where Project is located before site clearing.

E. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

F. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

G. Do not direct vehicle or equipment exhaust towards protection zones.

H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

I. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving".

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction. Provide tree protection.

B. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated. Flag per City of Wilmington Tree Protection Detail.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

A. General: Protect trees and plants remaining on-site.

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Landscape Architect.

3.4 EXISTING UTILITIES

A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.

1. Verify that utilities have been disconnected and capped before proceeding with site clearing.

B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed per Section 331000 "Water Utility Distribution Piping" and Section 334101 "Sanitary Utility Sewerage Piping".

1. Arrange with utility companies to shut off indicated utilities.
2. Owner will arrange to shut off indicated utilities when requested by Contractor.

C. Locate, identify, and disconnect utilities indicated to be abandoned in place.

D. Interrupting Existing Utilities: Refer to Section 011000 "Summary".

E. Excavate for and remove underground utilities indicated to be removed.

F. Removal of underground utilities is included in earthwork sections and with applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security and utilities sections.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Grind down stumps and remove roots, obstructions, and debris.
3. Use only hand methods for grubbing within protection zones.
4. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material placement in horizontal layers shall be in accordance with Section 312000 "Earth Moving".

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to 72 inches.
2. Do not stockpile topsoil within protection zones.
3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 311000

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SECTION 312000 – EARTH MOVING

PART 1 - GENERAL

1.1 GENERAL

A. The contractor shall furnish all labor, equipment, supplies and materials, and perform all operation in connection with the excavations, grading and backfilling, including borrow for drainage structures, curb and gutter, sidewalks, driveways, pavements, slopes, storm drains, water and sanitary sewer lines, including all hauling, wetting, rolling and other operations pertaining thereto within the clearing limits, complete, in strict accordance with this section of the specifications and the applicable drawings, and subject to the terms and conditions of the contract.

1.2 EXISTING CONDITIONS

A. Every reasonable effort has been made to provide accurate information on existing site conditions. The Contractor should become familiar with the site and satisfy himself as to the scope of the work involved and the materials to be encountered. Any significant change in conditions should be immediately brought to the attention of the Owner's representative.

1.3 REFERENCES

A. ASTM C33 - Standard specification for concrete aggregates

B. ANSI/ASTM C136 - Sieve analysis of fine and coarse aggregates.

C. ANSI/ASTM D698 - Tests for moisture-density relations of soils and soil-aggregate mixture using 5.5 lb (2.49 kg) rammer and 12 inch (305 mm) drop.

D. ANSI/ASTM D1556 - Density of soil in place by sand-cone method.

E. ASTM D2487 - Classification of soils for engineering purposes.

PART 2 - PRODUCTS

2.1 SOILS

A. General: Use soils free of organic matter, refuse, rocks and lumps greater than 4 inches in diameter and other deleterious matter. All backfill material located in grass areas and in areas of landscape shall have a PH between 5.5 and 7.0 (refer to landscape specification).

1. Backfilling Materials: Suitable material, when used as backfill in paved areas, shall be capable of being compacted as specified in paragraph "Compaction and Testing" of this section of these specifications.

a. Type 1 Material: Excavated material from the trench or materials from other sources which are free from large clods, roots or stones larger than 1 inch may be used as initial backfill in trenches (see Trench Details)

b. Type 2 Material: Excavated material from the trench or materials from other sources which are free from large clods, roots or stones larger than 8 inches may be used as final backfill in trenches (see Trench Details)

B. Classification: For the purpose of this specification, soils to be used as fill material are grouped into seven classes according to soil properties and characteristics.

Class I - Angular, 6 to 40-mm (1/4 to 1-1/2 in.), graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, crushed gravel, and crushed shells (Reference Geotechnical Report and Recommendation).

Class II - Coarse sands and gravels with maximum practical size of 44 mm (1-1/2 in.), including variously graded sands and gravels containing small percentages of fines, such as clayey sands and silty sands. Soil Types GW, GP, SW, SP, SP-SM, SP-SC or SM are included in this class as recommended by the Geotechnical Engineer.

Class III - Fine sand and clayey gravels, including fine sands, sand-clay mixtures, and gravel-clay mixtures. Soil Types GM, GC, SM, and SC are included in this class.

Class IV - Silt, silty clays, and clays, including inorganic clays and silts of medium to high plasticity and liquid limits. Soil Types MH, ML, CH, and CL are included in this class. These materials are not recommended for bedding, haunching, or initial backfill.

Class V - This class includes the organic soil, OL, OH, PT as well as soils containing frozen earth, debris, rocks, larger than 40 mm (1-1/2 in.) in diameter, and other foreign materials. These materials are not recommended for bedding haunching or initial backfill.

C. Topsoil: Natural, friable soil free of subsoil, stumps, rocks larger than 2 inches in diameter, weeds and other material detrimental to plant growth.

D. Granular Fill: Granular fill under floor slabs shall be Class I material.

E. Structural Fill: Fill material placed inside the line of the building foundation or slab shall be Class I, II or III per recommendations of the Geotechnical Engineer.

F. Fill Beneath Pavement: Fill material used beneath pavement and for road shoulders shall be Class II or III.

G. General Fill: General fill material not otherwise specified shall be Class II or III.

H. Trench Backfill: Material used for bedding, haunching and initial backfill shall be as specified hereinafter.

2.2 CRUSHED STONE

A. Crushed stone shall be size no. 57, with fines present to stabilize it in the trench. If fines are insufficient, stone screenings shall be added to extent required to stabilize it in the trench.

PART 3 - EXECUTION

3.1 GENERAL

A. Familiarization: Prior to commencement of the earthwork, become thoroughly familiar with the site, the site conditions, and all portions of the work specified in this Section.

B. Approvals: Backfilling and grading operations near foundations, walls, pipes and other portions of the work to be covered shall not commence until the Owner's Representative has completed all required inspections, tests and approvals. Work covered prior to inspection shall be uncovered for inspection purposes and backfilled.

3.2 SURFACE PREPARATION

A. Clearing: Areas designated for clearing and required for construction operations shall be cleared of trees, brush, structures and other materials. Trees which are to remain shall be protected during clearing operations and subsequent work.

B. Grubbing: Roots, stumps and other materials shall be grubbed from the cleared areas to a depth of at least 18 inches. Tree stumps shall be grubbed in their entirety, including tap roots where applicable.

C. Topsoil: Strip existing topsoil from areas to be excavated or graded. Stockpile the topsoil in a suitable area for use during final grading operations. Protect the topsoil from excessive erosion.

D. Unsuitable Material: Remove sod, muck or other unsuitable material to firm subsoil in areas designated for filling or grading operations.

E. Disposal: Trees, stumps, roots, rubbish, unsuitable soil or other material resulting from surface preparation shall be removed from the site by the Contractor and disposed of.

3.3 EXCESS WATER CONTROL

A. General: Grade and maintain all areas of the site to preclude surface runoff into excavations and prevent ponding of water.

B. Dewatering: Excavations should be kept free of surface water and/or groundwater. Dewatering is the responsibility of the contractor and shall be included in the bid.

Provide and maintain at all times the necessary means and devices to prevent water from entering the excavations and for removing all water entering the excavations.

C. Softened Subgrade: Remove all soil softened or eroded by the presence of water and replace with suitable backfill material.

3.4 EXCAVATION

Excavation shall be accomplished in accordance with the grades and lines as established by the Architect / Engineer and as required by the work to be performed. Excavation shall include the removal and replacement of all asphalt, concrete, curb, rock, earth, fences, trees (as directed by the Architect / Engineer), shrubs, and other materials as applicable. The contractor will exercise care to prevent undercutting lower than the required subgrades. All materials from excavation, considered as suitable by the Architect / Engineer, shall be used as fill wherever required, and the Contractor shall arrange his work so that this usage of excavated materials will be possible. Unsuitable and surplus materials from excavation, if any, shall be disposed of by the Contractor at this expense. All areas of the site shall be graded and maintained at all times to prevent surface runoff from draining into the excavations, and to prevent ponding of water therein.

Excavated materials not required for topsoil, fill or backfill shall be removed from the site of the work by the Contractor, but none shall be deposited on private property without written consent of the property owner.

A. Unsuitable Materials: Unsuitable materials encountered in an excavation shall be removed as directed by the Owner's representative, backfilled with suitable material and compacted. Unsuitable materials include organic soils, muck, soft and compressible silts and clays and running sands.

B. Undercutting: Undercutting, unless authorized by the Architect / Engineer, shall be replaced and compacted, as specified in paragraph 3.6, at the Contractor's expense. If the material, after excavation to subgrade, is found to be soft, spongy or unfit for use as subgrade, such unsuitable material shall be removed to a depth as directed by the Architect / Engineer and the subgrade shall be brought to proper elevation by filling with suitable material from excavation or from an approved borrow site.

C. Borrow: The Contractor will supply all borrow necessary and will provide all labor and equipment necessary to dig and haul such borrow. The placing of borrow shall be as provided for in the paragraph 3.6.

3.5 PREPARATION OF SUBGRADE

A. General: Upon completion of site preparation and excavation, scarify to a depth of 12 inches and compact as specified. For areas to receive fill, the compacted subgrade shall be scarified to a depth of four inches prior to placing the fill.

3.6 FILL AND COMPACTION

A. When and where existing plans and grades require the use of fill to reach the required elevation, the Contractor shall deposit suitable material. Such material shall be free from debris, roots, trash, stones, or other harmful substances, and shall be spread in successive layers of loose material not more than 8 inches in depth. Each layer shall be spread uniformly and rolled with an approved tamping or three-wheeled power roller until thoroughly compacted to a minimum of 98 percent of the standard Proctor maximum dry density (ASTM D-698). The moisture content of the fill should be within +/- 3 percent of the material's standard Proctor optimum moisture content for SP-SM, SP-SC, or SM, and within +/- 5 percent for SW or SP soils. To confirm that the specified degree of compaction is being obtained, field density testing should be performed in each fill by the geotechnical engineer's representative. We recommend that density tests be performed at a minimum frequency of one test per 2,500 square feet per lift in building and pavement areas, and one test per 100 linear feet per lift of utility trench backfill in structural areas. When any portion of the fill is constructed on an old road bed, the existing surfaces shall be scarified and manipulated as directed by the Architect / Engineer in order that, when compacted, it shall have a uniform density, as specified above. Fills shall be shaped and maintained at all times during their construction to prevent an accumulation of standing water in the event of rain.

B. Moisture Conditioning: Moisten or aerate the subgrade and fill material as required to obtain proper compaction.

C. Structural Fill: Compact the subgrade and fill to a minimum of 98 percent ASTM D698 (Standard Proctor) maximum density at optimum moisture content.

D. Granular Fill (ABC Stone): Place granular fill on compacted, unscarified fill or subgrade and compact to a minimum 100 percent modified ASTM D1557, maximum density at optimum moisture content.

E. Pavement Areas: Compact the soil subgrade and fill material beneath paved areas and shoulders to a minimum 98 percent ASTM D698 maximum density at optimum moisture content.

F. Landscaped Areas: Compact the subgrade and fill to a minimum 95 percent ASTM D698 maximum density at optimum moisture content. Compact topsoil to 85 percent ASTM D698 maximum density at optimum moisture content.

3.7 FINISH GRADING

A. General: Perform finish grading to the lines and grades shown on the drawings. Finished grades should be smooth and uniform and provide positive drainage.

B. Tolerances:

1. Rough Grade Plus or minus 0.1 foot

2. Finish Grade Plus or minus 0.1 foot

C. Topsoil: The top 4 inches of soil in landscaped areas shall be topsoil.

D. Protection: Protect areas which have been graded from equipment traffic.

3.8 TRENCHING, BACKFILLING AND COMPACTION FOR UTILITY SYSTEMS

A. General: Refer to specific utility sections in these specifications for installation requirements. Trench, backfill and compact as specified except as modified herein.

B. Trenching: Trench widths at and below the top of the pipe shall be the minimum necessary for proper installation. Trench banks above the top of the pipe shall be as vertical as practicable. Overdepth excavation shall be backfilled with Class I material and compacted. The Contractor shall provide, at his expense and as directed by the Owner's representative, special bedding material or concrete encasement as may be necessary due to over-width excavation.

C. Depth: Trench to the lines and grades shown on the drawings. Where elevations are not shown, trench to a depth sufficient to provide at least 36 inches of cover above the top of pipe, unless otherwise specified. Grade trenches to provide a constant slope free of sags and high spots.

D. Dewatering: Keep trenches free of water. Include cost of dewatering in bid for pipe.

E. Trench Bracing: Properly brace, sheet and support trench walls as soil conditions indicate and in strict conformance with all pertinent laws and OSHA regulations. Provide adequate bracing and shoring to protect adjacent improvements. Contractor shall provide certification for all premanufactured trench bracing devices prior to any excavation activities.

F. Bedding, Haunching and Initial Backfill: Tamp to provide firm, even bedding. Excavate bedding material to match the shape of the bottom of the pipe and bell, as detailed in the drawings. Place haunching material so as to provide full bearing around the bottom of the pipe. Place bedding haunching and initial backfill as specified below.

G. Pipe Bedding:

1. P.V.C. Gravity Main - Provide six (6) inches of Class I bedding material compacted to 98 percent ASTM D698 density. Haunching material shall be Class I material compacted to 98 percent ASTM D698 density. Haunching of pipe from invert to springline shall be by hand placement to ensure material is worked under Haunch. Initial backfill shall be Class I to top of pipe (washed 157 stone preferred).

2. D.I.P. and C900/905 PVC Gravity Main - Provide six (6) inches of Class I bedding material compacted to 98 percent ASTM D698 density. Haunching material shall be Class I material compacted to 98 percent ASTM D698 density. Haunching of pipe from invert to springline shall be by hand placement to ensure material is worked under Haunch. Initial backfill shall be Class I to springline of pipe Class I, II or III material to top of pipe.

3. Pressure Main P.V.C. or D.I.P. - Provide six (6) inches of Class I or II bedding material compacted to 98 percent ASTM D698 density. Haunching material shall be Class I or II material compacted to 98 percent ASTM D698 density. Haunching of pipe from invert to springline shall be by hand placement to ensure material is worked under Haunch. Initial backfill shall be Class I or Class II to top of pipe Class I, II or III material from top of pipe to 6-inches above pipe.

4. Service Pipe (Schedule 40) - Provide six (6) inches of Class I or II bedding material compacted to 98 percent ASTM D698 density. Haunching material shall be Class I or II material compacted to 98 percent ASTM D698 density. Haunching of pipe from invert to springline shall be by hand placement to ensure material is worked under Haunch. Initial backfill shall be Class I or II to top of pipe.

H. Backfill: Backfill the remainder of the trench in accordance with paragraphs 2.01 and 3.06 of this section. Backfill from embedment zone to surface grade may be by hand of mechanical placement. Trench backfill shall be compacted in 8-inch lifts as in spec section 3.6.

I. Foundation: Pipe foundation shall be required in wet, yielding and mucky locations. Foundation shall be constructed by removal of wet, yielding or mucky material and its replacement with sufficient Class I material to correct the instability. In areas where foundation is required bedding shall be class I only.

J. Backfilling in Traffic Areas (Highways, paved streets, paved parking lots, alleys, driveways, highway and street shoulders)

1. Initial Backfilling of Pipe (Ordinary Bedding for DIP Pipe)

a. After preparing the trench for ordinary bedding as described under paragraph 3.08G of this section, this portion of the pipe trench shall be backfilled with suitable materials (Type 1) under and around the pipe, carefully deposited in uniform layers on both sides of pipe and compacted by hand or pneumatic tampers until backfill reaches one (1) foot above top of pipe. The depth of backfill layers shall be six (6) inches maximum. Each layer of material shall be compacted to a dry density 95 percent of the maximum determined by the Standard Proctor Compaction Test.

b. When crushed stone or concrete encasement is used, the initial backfill of suitable materials will not be required.

c. The tampers shall be of proper sized to operate between trench wall and pipe without damaging the pipe.

2. Initial Backfilling of Pipe (Crusted Stone Encasement for PVC pipe, DIP in unstable or wet conditions, or crushed stone encasement)

a. This portion of the pipe trench shall be backfilled with crushed stone to provide crusted stone encasement.

b. When concrete cradle is used, the initial backfill will start at the top of the concrete and then continue as specified above.

c. When concrete encasement is used, the initial backfill of crushed stone will not be required.

3. Backfilling Trench to Subgrade After Initial Backfilling (Suitable Materials)

a. After initial backfilling has been compacted as specified above, backfill the remainder of the trench in compacted layers not to exceed twelve (12) inches using a mechanical tamper up to the bottom elevation of the pavement structure with suitable materials (Type 2) to be a dry density 95 percent of the maximum determined by the Modified Proctor Compaction Test.

3.9 FIELD QUALITY CONTROL

A. Field inspection, sampling and testing will be performed per owner's instructions.

END OF SECTION 312000

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SECTION 313116 - TERMITE CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Soil treatment with termiticide.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include the EPA-Registered Label for termiticide products.

1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Soil Treatment Application Report: Include the following:

1. Date and time of application.
2. Moisture content of soil before application.
3. Termiticide brand name and manufacturer.
4. Quantity of undiluted termiticide used.
5. Dilutions, methods, volumes used, and rates of application.
6. Areas of application.
7. Water source for application.

C. Letter from General Contractor certifying the General Contractor’s Superintendent observed the application of the termiticide and that the termiticide was applied in all locations at the manufacturer’s recommended rates.

D. Warranties: Sample of special warranties.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located and who employs workers trained and approved by manufacturer to install manufacturer's products.

B. Regulatory Requirements: Formulate and apply termiticides and termiticide devices according to the EPA-Registered Label.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.

B. Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

1.6 WARRANTY

A. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work, consisting of applied soil termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.

1. Warranty Period: Three years from date of Acceptance by Owner.

1.7 MAINTENANCE SERVICE

A. Continuing Service: Beginning at Acceptance by Owner, provide 12 months' continuing service including monitoring, inspection, and re-treatment for occurrences of termite activity. Provide a standard continuing service agreement. State services, obligations, conditions, terms for agreement period, and terms for future renewal options.

PART 2 - PRODUCTS

2.1 SOIL TREATMENT

A. Termiticide: Provide an EPA-Registered termiticide, complying with requirements of authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to product's EPA-Registered Label.

1. Products: Subject to compliance with requirements available products that may be incorporated into the Work include, but are not limited to, the following:

    a. BASF Corporation, Agricultural Products; Termidor.
    b. Bayer Environmental Science; Premise 75.
    c. FMC Corporation, Agricultural Products Group; Dragnet FT.
    d. Syngenta; Demon TC.

2. Service Life of Treatment: Soil treatment termiticide that is effective for not less than three years against infestation of subterranean termites.

PART 3 - EXECUTION

3.1 APPLICATION, GENERAL

A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's EPA-Registered Label for products.

3.2 APPLYING SOIL TREATMENT

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil per termiticide label requirements, interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.

B. Proceed with application only after unsatisfactory conditions have been corrected.

C. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated except previously compacted areas under slabs and footings.

D. Application: Mix soil treatment termiticide solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of termiticide, according to manufacturer's EPA-Registered Label, to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction. Distribute treatment evenly.

1. Slabs-on-Grade: Beneath ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
2. Foundations: Adjacent soil, including soil along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing. Avoid soil washout around footings.
3. Masonry: Treat voids.
4. Penetrations: At expansion joints, control joints, and areas where slabs will be penetrated.

E. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.

F. Protect termiticide solution, dispersed in treated soils and fills, from being diluted until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

G. Post warning signs in areas of application.

H. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

END OF SECTION 313116

SECTION 316316 – AUGER CAST GROUT PILES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes auger cast grout piles.

1.2 UNIT PRICES

A. Contract Sum: Base Contract Sum on number and dimensions of piles from tip to pile top.

B. Work of this Section is affected as follows:

1. Pile Length: Additional payment for pile lengths in excess of that indicated, and credit for pile lengths less than that indicated, is calculated at unit prices stated in the Contract, based on net addition or deduction to total pile length as determined by Architect and measured to nearest 12 inches.
2. Unit prices include labor, materials, tools, equipment, and incidentals for excavation, grout fill, reinforcement, testing and inspection, and other items for complete pile installation.
3. Test piles that become part of permanent foundation system are considered as an integral part of the Work.
4. No payment is made for rejected piles, including piles out of specified tolerance or defective piles.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Design Mixtures: For each grout mixture.

C. Shop Drawings: For auger cast grout piles, prepared by or under the supervision of a qualified professional engineer.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Material certificates.

C. Equipment Data: Description of drilling and grout-pumping equipment.

D. Pile inspection reports.

E. Field quality-control reports.

1 1.6 QUALITY ASSURANCE

2 A. Welding Qualifications: Qualify procedures and personnel according to the following:

3 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
4 2. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

5 PART 2 - PRODUCTS

6 2.1 PERFORMANCE REQUIREMENTS

7 A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000
8 "Quality Requirements," to design piles, including comprehensive engineering analysis by a
9 qualified professional engineer, using performance requirements and design criteria indicated.

10 1. Design Loads: As indicated on Drawings.

11 2.2 STEEL REINFORCEMENT

12 A. Reinforcing Bars: ASTM A615/A615M, Grade 60 (Grade 420), deformed.

13 B. Single Bar Reinforcing: ASTM A722/A722M, high strength, threaded.

14 1. Mechanical Couplings: Screw-on type, capable of supporting the minimum ultimate tensile
15 strength of the coupled bars.

16 C. Centralizers: Devices to center steel reinforcement in excavation; spaced not less than 20 feet
17 o.c. for vertical piles.

18 2.3 CONCRETE MATERIALS

19 A. Portland Cement: ASTM C150/C150M, Type II. Supplement with the following:

20 1. Fly Ash: ASTM C618, Class C or Class F.

21 B. Fine Aggregate: ASTM C33/C33M with 100 percent passing a No. 8 sieve, free of materials with
22 deleterious reactivity to alkali in cement. Provide aggregate from single source.

23 C. Water: ASTM C94/C94M and potable.

24 D. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other
25 admixtures. Do not use calcium chloride or admixtures containing calcium chloride.

26 1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
27 2. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
28 3. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
29 4. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

30 E. Fluidifier: ASTM C937, with expansion of less than 4 percent.

2.4 RELATED MATERIALS

A. Pile-Top Forms: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes.

2.5 GROUT MIXTURES

A. Proportion grout mixture as follows:

1. Minimum Compressive Strength: 5000 psi at 28 days; ASTM C109/C109M with cube specimens restrained from expansion according to ASTM C942.
2. Maximum Water-Cementitious Materials Ratio: 0.43.
3. Grout Flow: 10 to 25 seconds; ASTM C939 and ASTM C109/C109M using a flow cone with 0.75-inch opening.

2.6 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.7 GROUT MIXING

A. Ready-Mixed Grout: Measure, batch, mix, and deliver according to ASTM C94/C94M, and furnish batch ticket information.

PART 3 - EXECUTION

3.1 DRILLING AND PUMPING EQUIPMENT

A. Drilling Rig: Capable of advancing hollow-stem, continuous-flight augers of design diameters to depths 20 percent greater than design depths; with stabilizing arm at bottom of leads to prevent rotation, and middle guide for augers greater than 40 feet in length.

B. Hollow-Stem Auger: Continuous auger flighting without gaps or breaks, of diameter no more than 3 percent less than pile diameter; with grout pumping hole at bottom of auger head below cutting teeth. Seal grout-pumping hole with temporary tip plug to be fully opened by grout pressure or reinforcing bar during grout installation.

1. Hollow Shaft Diameter: Minimum 1-1/4-inch clear ID.

C. Grout Pump: Positive-displacement pump with a known volume per stroke. Minimum displacement pressure at pump of 350 lbf/sq. in..

D. Automated Monitoring Equipment: Capable of measuring auger depth, penetration rate, and grout volume pumped per unit depth increment and of printing results.

3.2 EXCAVATION

A. Excavate piles to elevations indicated or auger refusal. Establish and maintain axial alignment of leads and shaft before and during driving.

1. Auger Refusal: Rate of less than 1 fpm.

B. Drilling Tolerances:

1. Location: Pile centers maximum 3 inches from locations indicated.
2. Plumb: Within 2 percent from vertical.

3.3 INSTALLATION

A. Grout Placement: Place grout in continuous operation.

1. Lift auger 6 to 12 inches at start of grout pumping to facilitate tip plug removal, then return to previously established tip elevation.
2. Develop an initial grout head of 60 inches before start of auger withdrawal and maintain during extraction.
3. Monitor pumped grout volumes using automated monitoring equipment.
4. Volume of placed grout is at least 115 percent of theoretical volume. If less than required volume is placed for any given 60-inch segment, lower auger a minimum of 60 inches, or to bottom of pile if less than 60 inches available, and restart withdrawal.
5. If grout pumping is interrupted during placement, lower auger a minimum of 60 inches, or to bottom of pile if less than 60 inches available, and restart withdrawal.

B. Steel Reinforcement Installation, General: Comply with recommendations in CRSI's "Manual of Standard Practice."

C. Reinforcing Cages: Install immediately after grout placement and support at ground surface until initial set. Allow cages to fall into shaft freely under their own weight; do not force by vibrating or pushing with mechanical equipment.

D. Adjacent Piles: Do not install piles within 6 pile diameters of piles grouted within the previous 12 hours.

E. If location or out-of-plumb tolerances are exceeded, provide corrective construction. Submit corrective construction proposals to Architect for review before proceeding.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Pile excavation, placement, and testing.
2. Steel reinforcement welding.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Grout Tests: Testing of samples of fresh grout obtained according to ASTM C172/C172M shall be performed according to the following requirements:

1. Flow Rate: ASTM C939 and ASTM C109/C109M using a flow cone with 0.75-inch opening.
2. Compressive Strength: ASTM C109/C109M with cube specimens restrained from expansion according to ASTM C942.

a. Testing Frequency: Obtain six 2-inch cubes for each 50 cu. yd. or fraction thereof of grout placed, but not less than one set for each day's pour. Obtain an additional set of cubes from each truck during test pile placement.

b. Strength of each grout mixture is satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Pile Inspection Reports: Prepare inspection reports for each auger cast grout pile.

1 END OF SECTION 316316

2

SECTION 321216

ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cold milling of existing asphalt pavement.
2. Hot-mix asphalt patching.
3. Hot-mix asphalt paving.
4. Pavement Markings
5. Concrete Wheel Stops
6. Hot-mix asphalt overlay.
7. Asphalt surface treatments.

B. Related Requirements:

1. Section 024119 "Selective Demolition" for demolition and removal of existing asphalt pavement.
2. Section 312000 "Earth Moving" for subgrade preparation, fill material, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.
3. Section 321373 "Concrete Paving Joint Sealants" for joint sealants and fillers at pavement terminations.
4. Section 321400 "Unit Paving" for pavers above asphalt paving.

1.3 PREINSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project site.

1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:

    a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
    b. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include technical data and tested physical and performance properties.
2. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
3. Job-Mix Designs: For each job mix proposed for the Work.

B. Samples for Verification: For the following product, in manufacturer's standard sizes unless otherwise indicated:

1. Paving Fabric: 12 by 12 inches minimum.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer and testing agency.

B. Material Certificates: For each paving material. include statement that mixes containing recycled materials will perform equal to mixes produced from all new materials.

C. Material Test Reports: For each paving material, by a qualified testing agency.

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the NCDOT.

B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.

C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of NC DOT for asphalt paving work.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Prime Coat: Minimum surface temperature of 60 deg F.
2. Tack Coat: Minimum surface temperature of 60 deg F.
3. Slurry Coat: Comply with weather limitations in ASTM D 3910.
4. Asphalt Base or Intermediate Course: Minimum surface temperature of 35 deg F and rising at time of placement.
5. Asphalt Surface Course: Minimum surface temperature of 40 deg F at time of placement.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: ASTM D 692/D 692M, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.

C. Fine Aggregate: ASTM D 1073, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.

1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

D. Mineral Filler: ASTM D 242/D 242M, rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO M 320, PG 64-22

B. Emulsified Asphalt Prime Coat: Comply with NCDOT requirements.

C. Tack Coat: ASTM D 977 emulsified asphalt, or ASTM D 2397 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

D. Water: Potable.

E. Undersealing Asphalt: ASTM D 3141/D 3141M; pumping consistency.

2.3 AUXILIARY MATERIALS

A. Recycled Materials for Hot-Mix Asphalt Mixes: Reclaimed asphalt pavement; reclaimed, unbound-aggregate base material; and recycled tires, asphalt shingles or glass from sources and gradations that have performed satisfactorily in previous installations, equal to performance of required hot-mix asphalt paving produced from all new materials.

B. Herbicide: Commercial chemical for weed control, registered by the EPA, and not classified as "restricted use" for locations and conditions of application. Provide in granular, liquid, or wettable powder form.

C. Sand: ASTM D 1073 Grade No. 2 or No. 3.

D. Joint Sealant: ASTM D 6690, Type II or III hot-applied, single-component, polymer-modified bituminous sealant.

E. Pavement Markings to include:
1. Directional Arrows.
2. Parking Striping.
3. Lane Striping.
4. Stop Bars.

5. Accessible Parking and Aisle Markings.
6. Reserved Parking Space Markings.

F. Pavement Marking Paint
1. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready misted, complying with AASHTO M 248, colors complying with FS TT-P-1952.
2. Pavement-Marking Paint: MPI #97, latex traffic-marking paint.

G. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength, 4-1/2 inches high by 9 inches wide by 72 inches long. Provide chamfered corners and drainage slots on underside and holes for anchoring to substrate.

2.4 MIXES

A.

1. Surface Course Limit: Recycled content percentages by weight compliant with NCDOT shall be allowed.

B. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes approved by NCDOT and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.

2. Types:
   a. Heavy Duty
      1) Surface Course: S-9.5C; depth as indicated in drawings; installed in two lifts.
   b. Light Duty
      1) Surface Course: S-9.5C; depth as indicated in drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

1. Mill to a depth of 1-1/2 inches .
2. Mill to a uniform finished surface free of excessive gouges, grooves, and ridges.
3. Control rate of milling to prevent tearing of existing asphalt course.
4. Repair or replace curbs, manholes, and other construction damaged during cold milling.
5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
6. Patch surface depressions deeper than 1 inch after milling, before wearing course is laid.
7. Handle milled asphalt material according to approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."
8. Keep milled pavement surface free of loose material and dust.
9. Do not allow milled materials to accumulate on-site.

3.3 PATCHING

A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of 0.05 to 0.15 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

C. Placing Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

D. Placing Patch Material: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.4 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.

1. Clean cracks and joints in existing hot-mix asphalt pavement.
2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3.5 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.

C. Emulsified Asphalt Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.10 to 0.30 gal./sq. yd. per inch depth. Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
2. Protect primed substrate from damage until ready to receive paving.

D. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.6 PLACING HOT-MIX ASPHALT

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
2. Place hot-mix asphalt surface course in single lift.
3. Spread mix at a minimum temperature of 250 deg F .
4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Overlap mix placement about 1 to 1-1/2 inches from strip to strip to ensure proper compaction of mix along longitudinal joints.
2. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.7 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.8 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the f

D. ollowing density:

1. Density: Comply with most recent NCDOT requirements. Performance standards noted below are based on NCDOT 2018 Standard Specifications.
   a. Hot-mix asphalt Type SF-9.5B - Minimum 90 percent of maximum specific gravity density according to NC DOT.
   b. Hot-mix asphalt other than Type I19.0B - Minimum 92 percent of maximum specific gravity density according to NC DOT.

E. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

F. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

G. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

H. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

I. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.9 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.
2. Surface Course: 1/8 inch.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.10 SURFACE TREATMENTS

A. Fog Seals: Apply fog seal at a rate of 0.10 to 0.15 gal./sq. yd. to existing asphalt pavement and allow to cure. With fine sand, lightly dust areas receiving excess fog seal.

B. Slurry Seals: Apply slurry coat in a uniform thickness according to ASTM D 3910 and allow to cure.

1. Roll slurry seal to remove ridges and provide a uniform, smooth surface.

3.11 PAVEMENT MARKINGS

A. Apply thermoplastic pavement marking to crosswalks, directional arrows, lane markings, and traffic bars only.

B. Apply latex traffic marking paint to parking stalls and aisles.

C. Do not apply pavement-making paint until layout, colors, and placement have been verified with Architect and Owner.

D. Allow paving to age for 30 days before starting pavement marking.

E. Sweep and clean surface to eliminate loose material and dust.

F. Apply thermoplastic pavement-marking with mechanical equipment to produce pavement markings, of standard NC DOT dimensions, with uniform, straight edges. Apply per manufacturer's recommendations.

3.12 WHEEL STOPS

A. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength, 4-1/2 inches high by 9 inches wide by 72 inches long. Provide chamfered corners and drainage slots on underside and holes for anchoring to substrate.

1. Dowels: Galvanized steel, 3/4 inch in diameter, 10-inch minimum length.

B. Install wheel stops in bed of adhesive as recommended by manufacturer.

C. Securely attach wheel stops to pavement with not less than two galvanized-steel dowels embedded at one-quarter to one-third points. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

3.13 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. Asphalt Traffic-Calming Devices: Finished height of traffic-calming devices above pavement will be measured for compliance with tolerances.

E. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.

    a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than three cores taken.
    b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

F. Replace and compact hot-mix asphalt where core tests were taken.

G. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.14 WASTE HANDLING

A. General: Handle asphalt-paving waste according to approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

END OF SECTION 321216

SECTION 321313.13 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Driveways.
2. Walks and plazas.
3. Curbs and gutters.

B. Related Sections:

1. Division 03 Section “Landscape Architectural Concrete” for general building applications of concrete.
2. Division 32 Section "Decorative Concrete Paving" for stamped concrete
3. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Design Mixtures for Credit ID 1: For each concrete mixture containing fly ash as a replacement for portland cement or other portland cement replacements. For each design mixture submitted, include an equivalent concrete mixture that does not contain portland cement replacements, to determine amount of portland cement replaced.

C. Samples for Verification: For each type of product or exposed finish, prepared as Samples of size indicated below:

D. Other Action Submittals:

1. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified ready-mix concrete manufacturer.

B. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Fiber reinforcement.
4. Admixtures.
5. Curing compounds.
6. Applied finish materials.

C. Material Test Reports: For each of the following:

1. Aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

D. Field quality-control reports.

E. Product Submittals: Submit cut sheets of detectable warning paver selection. Include paver choice and color.

1.6 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

B. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

C. Slip Resistance: The project shall conform to the Occupational Safety and Health Administration recommendations for walking surfaces have a static coefficient of friction of 0.5. A static coefficient of friction of 0.6 is required for accessible routes and 0.8 for ramps.

D. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.

E. ACI Publications: Comply with ACI 301 unless otherwise indicated.

F. Pre-installation Conference: Conduct conference at Project site.

1. Review methods and procedures related to concrete paving, including but not limited to, the following:

    a. Concrete mixture design.
    b. Quality control of concrete materials and concrete paving construction practices.
    c. Sub base and base preparation
    d. Form work layout
    e. Finish, finish tools and finishing process

2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:

    a. Contractor's superintendent.
    b. Independent testing agency responsible for concrete design mixtures.
    c. Concrete paving subcontractor.

1.7 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces. Use material appropriate to obtain the correct quality and alignments.

1. Use 2” thick wood forms or formed steel forms for straight lines and rectangular applications

2. Use flexible forms capable of delivering smoothly curved formwork free of kinks, bulges, or flats. Forms can be steel, plastic or wood, but must have adequate joining methods to allow the smooth flow of curved lines through the union of form sections.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from steel wire into flat sheets.

C. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

D. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars galvanized after fabrication according to ASTM A 767/A 767M, Class I coating. Cut bars true to length with ends square and free of burrs.

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: ASTM C 150, gray Portland cement Type I. The following are allowed supplements:

a. Fly Ash: ASTM C 618, Class F.
b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33, Class 4S, uniformly graded. Provide aggregates from a single source.

1. Maximum Coarse-Aggregate Size: 1 inches nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: Potable and complying with ASTM C 94/C 94M.

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.4 CURING MATERIALS

A. Water: Potable.

B. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Anti-Hydro International, Inc.; A-H Curing Compound #2 DR WB.
b. ChemMasters; Safe-Cure Clear.
c. Conspec by Dayton Superior;
d. Dayton Superior Corporation; Day-Chem Rez Cure (J-11-W).
e. Edoco by Dayton Superior;

f. Euclid Chemical Company (The), an RPM company; Kurez W VOX.
g. Kaufman Products, Inc.; Thinfilm 420.
h. Lambert Corporation; AQUA KURE - CLEAR.
i. L&M Construction Chemicals, Inc.; L&M CURE R.
j. Meadows, W. R., Inc.; 1100-CLEAR SERIES.
k. Nox-Crete Products Group; Resin Cure E.
l. SpecChem, LLC; PaveCure Rez.
m. Symons by Dayton Superior; Resi-Chem Clear.
n. Tamms Industries, Inc., Euclid Chemical Company (The); TAMMSCURE WB 30C.
o. TK Products, Division of Sierra Corporation;.
p. Vexcon Chemicals Inc.; Certi-Vex Enviocure 100.

2.5 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
2. When automatic curb and gutter machine placement is used, determine design mixtures and obtain laboratory test results that meet or exceed requirements.

B. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days):
   a. Heavy Duty (Vehicular, Vehicular Drive, Curb & Gutter, Service and Loading Area): 4000 psi.
   b. Light Duty (Pedestrian Walkways, Plazas): 3500 psi.
2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.50.
3. Slump Limit: 5 inches, plus or minus 1 inch.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content: 5-1/2 percent plus or minus 1.5 percent.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing admixture or plasticizing and retarding admixture in concrete as required for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

F. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:

1. Fly Ash or Pozzolan: 25 percent.
2. Ground Granulated Blast-Furnace Slag: 50 percent.
3. Combined Fly Ash or Pozzolan, and Ground Granulated Blast-Furnace Slag: 50 percent, with fly ash or pozzolan not exceeding 25 percent.

2.6 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances. Grades should be compacted, smooth and free of dips, ridges or other potential snags that could cause less predictable cracking.

B. Proof-roll prepared base surface below concrete paving to identify soft pockets and areas of excess yielding.

1. Completely proof-roll base in one direction [for pedestrian applications] and repeat in perpendicular direction [for vehicular applications]. Limit vehicle speed to 3 mph.
2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Correct base with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Division 31 Section "Earth Moving." Do not fill with concrete.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove loose material from compacted base surface immediately before placing concrete.

B. Place and compact base materials according to “Hot Mixed Asphalt Paving” specifications for ABC gravel.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.

C. Expansion Joints: Form isolation joints of preformed joint-filler strips abutting buildings, columns, footings, concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.

1. Locate expansion joints at intervals shown in the drawings but not more than 40’.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
7. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows[, to match jointing of existing adjacent concrete paving]:

1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. [Eliminate edging-tool marks on concrete surfaces.]

3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation , steel reinforcement, and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into.

G. Consolidate concrete according to ACI 301 by hand spading, rodding, or tamping.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.

K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

L. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

M. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface by hand floating. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
   1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3.8 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by curing compound as follows:
   1. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas that have been subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.9 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 3/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch .
3. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed 3/8 inch.
4. Lateral Alignment and Spacing of Dowels: 1 inch.
5. Vertical Alignment of Dowels: 1/4 inch.
6. Contraction Joint Depth: Plus 1/4 inch, no minus.
7. Joint Width: Plus 1/8 inch, no minus.

8. Joint Spacing: as shown on the drawing
9. Joint alignment: when aligned with plan identified site element, ¼".
10. Edge alignment – no more than ½" out of alignment over 20'
11. Joint straightness – no more than ½" out of alignment over 20'

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for the first 20 yards and one each 100 cu. yd. thereafter or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.

    a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

H. Prepare test and inspection reports.

3.11 CONCRETE REJECTION AND REPLACEMENT

A. Concrete paving will be considered defective if it:
   1. Does not pass tests and inspections.
   2. Does not meet layout and alignments,
   3. Does not have a consistent color and texture
   4. Shows spalling, alligator cracking or cracking due to base failures.
   5. Jointing is installed after contraction cracking has occurred,
   6. Jointing and edges are not smooth curves or in straight lines as indicated by the drawings,
   7. Exceeds the gradients indicated on the plans,
   8. Does not adequately drain water away as shown on the drawings.

B. Defective concrete shall be removed immediately and replaced with acceptable concrete work at the Contractor’s expense.

3.12 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Final Acceptance inspections.

END OF SECTION 321313

SECTION 32 13 16

DECORATIVE CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes
   1. Integral colored and textured concrete paving for plaza pedestrian paving.
   2. Integral colored and textured vehicular concrete paving for plaza crosswalk paving.

B. Related Sections:

   1. Division 03 Section "Cast-in-Place Concrete" for general building applications of concrete.
   2. Division 03 Section "Architectural Concrete" for general building applications of specially finished formed concrete, and for integral colored and standard (non-integral colored) concrete site walls, including seating walls, retaining walls and benches.
   3. Division 32 Section "Concrete Paving" for cast-in-place concrete paving with other finishes, curbs and gutters, stamped detectable warnings, pavement markings, and wheel stops.
   4. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within decorative concrete paving and in joints between decorative concrete paving and asphalt paving or adjacent construction.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and ground granulated blast-furnace slag.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Design Mixtures for Credit ID 1: For each concrete mixture containing fly ash as a replacement for portland cement or other portland cement replacements. For each design mixture submitted, include an equivalent concrete mixture that does not contain portland cement replacements, to determine amount of portland cement replaced.

C. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color, pattern, or texture selection.

D. Samples for Verification: For each type of exposed color, pattern, or texture indicated.

E. Other Action Submittals:

1. Design Mixtures: For each decorative concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and ready-mix concrete manufacturer.

B. Material Certificates: For the following, from manufacturer. Provide compatibility information if from different manufactures:

1. Cementitious materials.
2. Admixtures.
3. Curing compounds.
4. Applied finish materials.

C. Material Test Reports: For each of the following:

1. Aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer of decorative concrete paving systems.

B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

C. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

D. Source Limitations: Obtain decorative concrete paving products and each type or class of cementitious material, color materials, curing agents and sealants of the same brand from same manufacturer's plant, and obtain each aggregate from single source.
1. Only provide materials that are compatible with each other and the intended design and installation.
2. Provide written compatibility certification for products outside the brand of color agents.

E. Project Conditions: Conduct integral colored concrete operations within a contiguous time period to insure same source cement materials, processes and weather conditions.

F. Slip Resistance: The project pavement shall conform to the Occupational Safety and Health Administration recommendations for walking surfaces have a static coefficient of friction of 0.5. A static coefficient of friction of 0.6 is required for accessible routes and 0.8 for ramps.

G. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.

H. ACI Publications: Comply with ACI 301 unless otherwise indicated.

I. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups of full-thickness sections of decorative concrete paving to demonstrate typical joints; surface color, pattern, and texture; curing; and standard of workmanship.
2. Build mockups of decorative concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Architect and not less than 96 inches by 96 inches.
3. Build (3) mockups, each showing varying degrees of finish.
4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
5. Approved mockups may not be part of the completed Work if undisturbed at time of Substantial Completion.

J. Pre-installation Conference: Conduct conference at the project site.

1. Review methods and procedures related to decorative concrete paving, including but not limited to, the following:

    a. Concrete mixture design and delivery.
    b. Quality control of concrete materials and decorative concrete paving construction practices.
    c. Uniformity of appearance goals
    d. Sub-base and base preparation
    e. Form work layout
    f. Finish, finish tools and finishing process
    g. Slip resistance of intended finishes

2. Require representatives of each entity directly concerned with decorative concrete paving to attend, including the following:

    a. Contractor's superintendent.
    b. Independent testing agency responsible for concrete design mixtures.
    c. Ready-mix concrete manufacturer.
    d. Decorative concrete paving Installer.
    e. Manufacturer's representative of decorative concrete paving system.

1.7 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Schedule concrete work only during job and weather that can produce consistent results.

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces. Use material appropriate to obtain the correct quality and alignments.

1. Use 2” thick wood forms or formed steel forms for straight lines and rectangular applications

2. Use flexible forms capable of delivering smoothly curved formwork free of kinks, bulges, or flats. Forms can be steel, plastic or wood, but must have adequate joining methods to allow the smooth flow of curved lines through the union of form sections.

B. Forms for Textured Finish Concrete: Units of face design, size, arrangement, and configuration indicated. Provide solid backing and form supports to ensure stability of textured form liners.

C. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawn steel wire into flat sheets.

C. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 ; deformed.

D. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars. Cut bars true to length with ends square and free of burrs.

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, gray Portland cement Type I, supplement with the following:

2. Polzzolans – Use the same material and amounts of fly ash in all batches of colored concrete

    a. Fly Ash: ASTM C 618, Class C or F.
    b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33, Class 4S, uniformly graded. Provide aggregates from a single source with the same color run.

1. Maximum Aggregate Size: 3/4 inch nominal.
    a. Color – Gray
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: Potable and complying with ASTM C 94/C 94M.

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and not detrimental to integral color or color consistency. Admixtures shall not to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
3. Water-Reducing and Accelerating Admixture: ASTM C 494/C 494M, Type E.

F. Integral Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.

1. Refer to plans and schedule article 3.16 of this section for color specifications.

2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Bon Tool Co.
    b. ChemMasters.
    c. Davis Colors.
    d. Lambert Corporation.
    e. QC Construction Products.
    f. Scofield, L. M. Company.
    g. Solomon Colors, Inc.
    h. Specialty Concrete Products, Inc.
    i. Stampcrete International Ltd.
    j. SureCrete Design Products.

2.4 CURING AND SEALING MATERIALS

A. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type I, Class A, manufactured for use with colored concrete.

1. Tinted to match integral colored concrete.

2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Advanced Surfaces Inc.
    b. Artcrete, Inc.
    c. Bon Tool Co.
    d. Brickform.
    e. Butterfield Color.
    f. H&C Concrete Care Products.
    g. Scofield, L. M. Company.
    h. Specialty Concrete Products, Inc.
    i. SureCrete Design Products.
    j. Symons by Dayton Superior.

B. Slip-Resistance-Enhancing Additive: Manufacturer's standard finely graded aggregate or polymer additive, designed to be added to clear acrylic sealer to enhance slip resistance of sealed paving surface.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Advanced Surfaces Inc.; Skid Guard.
    b. Bomanite Corporation; Bomanite Sure Trak.

c. Bon Tool Co.; Gator Grip.
d. H&C Concrete Care Products; SharkGrip.
e. QC Construction Products; QC Sure Trak
f. Southern Color N.A., Inc.; Mosaics Seal-Grip.
g. Symons by Dayton Superior; Grip Aid.
h. Vexcon Chemicals Inc.; Certi-Vex Grip.

2.5 RELATED MATERIALS

A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber in preformed strips.

2.6 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.

B. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days):
   a. Light Duty (Pedestrian): 3500 psi.
   b. Heavy Duty (Vehicular): 4000 psi.
2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.50.
3. Slump Limit: 5 inches, plus or minus 1 inch.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Colored Concrete:
   a. Air Content per pigment manufacturer’s recommendation.

2. All Other Decorative Concrete Types:
   a. Air Content: 5-1/2 percent plus or minus 1.5 percent.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions and are certified not to hinder color performance.

1. Use water-reducing admixture or water-reducing and retarding admixture or water-reducing and accelerating admixture in concrete as required for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Super plasticizers may only be added at the plant, not at the jobsite.

F. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash: 20 percent.
2. Ground Granulated Blast-Furnace Slag: 20 percent.
3. When combined use a maximum of 40 percent Fly Ash and Ground Granulated Blast Furnace Slag

G. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.7 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 and 90 deg F , reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F , reduce mixing and delivery time to 60 minutes.
2. Project-Site Mixing: Not allowed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below decorative concrete paving to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase according to requirements in Division 31 Section "Earth Moving
2. Proof-roll according to requirements in Division 31 Section "Earth Moving
3. Correct base with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Division 31 Section "Earth Moving." Do not fill with concrete.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove loose material from compacted base surface immediately before placing concrete.

B. Protect adjacent construction from discoloration and spillage during application of color hardeners, release agents, stains, curing compounds, and sealers.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.

C. Expansion Joints: Form isolation joints of preformed joint-filler strips abutting buildings, columns, footings, concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.

1. Locate expansion joints at intervals shown in the drawings but not more than 40’.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.

4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent decorative concrete paving]:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
   a. Chamfer [or radiused] enhanced sawed joints: use a diamond bit saw fitted with the ability to create an enlarged cut in the shape of a [bevel][radius]

3. Doweled Expansion Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten base or base to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. UNDER NO CIRCUMSTANCES SHALL WATER BE ADDED AFTER THE CONCRETE HAS BEEN MIXED AT THE PLANT.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using wooden bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. DO NOT WET TOOLS OR OTHERWISE ADD WATER TO THE CONCRETE SURFACE. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F , uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

K. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.
3. Only place concrete during hot weather if environmental conditions from pour to pour can be maintained to produce consistent color performance.

3.7 FLOAT FINISHING

A. General: DO NOT ADD WATER TO CONCRETE SURFACES OR TOOLS DURING FINISHING OPERATIONS.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

3.8 INTEGRALLY COLORED CONCRETE FINISH

A. Integrally Colored Concrete Finish: After final floating, apply the following finish:
   1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
   2. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 deep with a stiff-bristled broom, perpendicular to line of traffic.
   3. Rolled Finish – roll concrete with a heavily textured paint application roller.
   4. Sandblasted finish – apply a sandblasted medium shot finish in a uniform manner over the concrete surface.

3.9 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Curing and Sealing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.
   1. Provide color matched tinting.

D. Curing Paper: Do not use curing paper.

3.10 SEALER

A. Clear Acrylic Sealer: Apply uniformly in two coats in continuous operations according to manufacturer's written instructions. Allow first coat to dry before applying second coat, at 90 degrees to the direction of the first coat using same application methods and rates.

   1. Add sealant color at the factory.
   2. Begin sealing dry surface no sooner than 25 days after concrete placement
   3. Allow stained concrete surfaces to dry before applying sealer.
   4. Thoroughly mix tinting or slip-resistance-enhancing additive into sealer before applying sealer according to manufacturer's written instructions. Stir sealer occasionally during application to maintain even distribution of additive.

3.11 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

   1. Elevation: 3/4 inch .

2. Thickness: Plus 3/8 inch , minus 1/4 inch .
3. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed 3/8 inch .
4. Lateral Alignment and Spacing of Dowels: 1 inch .
5. Vertical Alignment of Dowels: 1/4 inch .
6. Contraction Joint Depth: Plus 1/4 inch , no minus.
7. Joint Width: Plus 1/8 inch , no minus.
8. Joint Spacing: as shown on the drawing
9. Joint alignment: when aligned with plan identified site element, ¼".
10. Edge alignment – no more than ½" out of alignment over 20'
11. Joint straightness – no more than ½" our of alignment over 20'

3.12 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for the first 20 yards and one each 100 cu. yd. thereafter or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.

    a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi .

D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Decorative concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.13 CONCRETE REJECTION AND REPLACEMENT

A. Concrete paving will be considered defective if it:
1. Does not pass tests and inspections.
2. Does not meet layout and alignments,
3. Does not have a consistent color and texture
4. Shows spalling, alligator cracking or cracking due to base failures.
5. Jointing is installed after contraction cracking has occurred,
6. Jointing and edges are not smooth curves or in straight lines as indicated by the drawings,
7. Exceeds the gradients indicated on the plans,
8. Does not adequately drain water away as shown on the drawings.
9. If the incorrect color has been used.
10. If there exists color variations that can be attributed to improper finishing, addition of water to concrete or finishing, delivery of unmatched concrete mixes, or the combination of incompatible concrete materials or admixtures.

B. Defective concrete shall be removed immediately and replaced with acceptable concrete work at the Contractor’s expense.

3.14 REPAIRS AND PROTECTION

A. Remove and replace decorative concrete paving that is broken or damaged or does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Detailing: Grind concrete "squeeze" left from tool placement. Color ground areas with slurry of color hardener mixed with water and bonding agent. Remove excess release agent with high-velocity blower.

C. Protect decorative concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain decorative concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

3.15 DECORATIVE CONCRETE PAVING SCHEDULE

AREA	COLORING METHOD			SEALANTS		TEXTURING		
AREA	INTEGRAL	COLOR HARDNER	STAIN	TINTED SEALANT	CLEAR SEALANT	TOOLED	TEXTURE	STAMPING
TYPE 1	MEDIUM GRAY)	NO	NO	NO	NO	BEAD BLAST/ CHEMICAL SURFACE RETARDER MEDIUM FINISH	NO	NO

Decorative concrete colors to be selected from manufacturer's full range of colors. Basis of design colors listed above are based upon Davis Colors Products.

END OF SECTION 321316

SECTION 321373.13 - CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cold-applied joint sealants.
2. Cold-applied, fuel-resistant joint sealants.
3. Joint-sealant backer materials.
4. Primers.

B. Related Requirements:

1. Section 079200 "Joint Sealants" for sealing nontraffic and traffic joints in locations not specified in this Section.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

C. Paving-Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and testing agency.

B. Product Certificates: For each type of joint sealant and accessory.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Product Testing: Test joint sealants using a qualified testing agency.

1.7 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

2.2 COLD-APPLIED JOINT SEALANTS

A. Single-Component, Nonsag, Silicone Joint Sealant: ASTM D 5893/D 5893M, Type NS.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Crafco Inc; RoadSaver Silicone.
b. Dow Corning Corporation; 888.
c. Pecora Corporation; 301 NS.

B. Single-Component, Self-Leveling, Silicone Joint Sealant: ASTM D 5893/D 5893M, Type SL.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Crafco Inc; RoadSaver Silicone SL.
b. Dow Corning Corporation; 890-SL.
c. Pecora Corporation; 300 SL.

C. Multicomponent, Nonsag, Urethane, Elastomeric Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use T.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Meadows, W.R., Inc.; Pourtane NS.

D. Single Component, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C 920, Type S, Grade P, Class 25, for Use T.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Meadows, W.R., Inc.; Pourtane SL.

E. Multicomponent, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C 920, Type M, Grade P, Class 25, for Use T.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Pecora Corporation; Dynatrol II-SG.

2.3 COLD-APPLIED, FUEL-RESISTANT JOINT SEALANTS

A. Fuel-Resistant, Single-Component, Pourable, Modified-Urethane, Elastomeric Joint Sealant: ASTM C 920, Type S, Grade P, Class 25, for Use T.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. BASF Building Systems; Sonomeric 1.

B. Fuel-Resistant, Multicomponent, Pourable, Modified-Urethane, Elastomeric Joint Sealant: ASTM C 920, Type M, Grade P, Class 12-1/2 or 25, for Use T.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Meadows, W.R., Inc; Sealtight Gardox.

    b. Pecora Corporation; Urexpan NR-300.

2.4 JOINT-SEALANT BACKER MATERIALS

A. Joint-Sealant Backer Materials: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint-sealant manufacturer, based on field experience and laboratory testing.

B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

C. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

D. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D 5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.5 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions.

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions.

C. Install joint-sealant backings to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of joint-sealant backings.
2. Do not stretch, twist, puncture, or tear joint-sealant backings.
3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install joint sealants immediately following backing installation, using proven techniques that comply with the following:

1. Place joint sealants so they fully contact joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:

1. Remove excess joint sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING AND PROTECTION

A. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.

B. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Final Acceptance. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.5 PAVING-JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Joints within concrete paving.

1. Joint Location:

    a. Expansion and isolation joints in concrete paving *for all concrete paving areas except concrete exposed to fuel areas such as service yards or roadways.*.

2. Joint Sealant: Single-component, nonsag, silicone joint sealant, Single-component, self-leveling, silicone joint sealant, Multicomponent, nonsag, urethane, elastomeric joint sealant, Single component, pourable, urethane, elastomeric joint sealant, and Multicomponent, pourable, urethane, elastomeric joint sealant.
3. Joint-Sealant Color: To match adjacent concrete paving within manufacturer’s standard range of colors – to be selected and approved by Architect.

B. Joint-Sealant Application: Fuel-resistant joints within concrete paving *that is exposed to fuel areas such as service yards or roadways.* .

1. Joint Location:

a. Expansion and isolation joints in concrete paving.

2. Joint Sealant: Fuel-resistant, single-component, pourable, modified-urethane, elastomeric joint sealant or Fuel-resistant, multicomponent, pourable, modified-urethane, elastomeric joint sealant]
3. Joint-Sealant Color: To match adjacent concrete paving within manufacturer's standard range of colors – to be selected and approved by Architect.

END OF SECTION 321373

SECTION 321613 – PORTLAND CEMENT CONCRETE PAVEMENT

1. GENERAL

1.1 DESCRIPTION OF WORK: Work described in this section is portland cement concrete paving, including curbs, gutters and walkways.

1.2 STANDARD SPECIFICATION: Provisions of the American Concrete Institute (ACI) and American Concrete Pavement Association "Municipal Concrete Pavement Manual" (ACPA) are included by reference.

2. PRODUCTS

2.1 FORMS: Steel, wood, or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects. Use flexible spring steel forms or laminated boards to form radius bends as required. Coat forms with a non-staining form release agent that will not discolor or deface surface of concrete.

2.2 CONCRETE MATERIALS: ACI 318, minimum compressive strength of 4000 psi at 28 days, with maximum slump of 5 inches. Air content 5% to 8%.

2.3 EXPANSION JOINT MATERIALS: Preformed expansion joint fillers ASTM D1751 and sealers, ASTM C920.

2.4 LIQUID-MEMBRANE FORMING CURING COMPOUND: Complying with ASTM C309, Type I, Class A.

2.5 BONDING COMPOUND: Polyvinyl acetate or acrylic base, rewettable type.

2.6 EPOXY ADHESIVE: ASTM C881, two component material suitable for use on dry or damp surfaces. Provide material "Type", "Grade", and "Class" to suit project requirements.

2.7 REINFORCING STEEL

2.7.1 Deformed Steel Bars: ASTM A615, Grade 60 for reinforcement, Grade 40 for tie bars.

2.7.2 Wire Fabric: ASTM A185.

2.7.3 Dowels: ASTM A663, Grade 65, smooth and round.

3. EXECUTION

3.1 SURFACE PREPARATION: Remove loose material from compacted subbase surface immediately before placing concrete. Do not begin paving work until subbase is ready to receive paving. Stringlines will be required to assure proper depth of concrete on all slabs. Absolutely no tolerance will be allowed on minimum slab thickness.

3.2 FORM CONSTRUCTION: Set forms to required grades and lines, rigidly braced and secured. Install sufficient quantity of forms to allow continuous progress of work and so that forms can remain in place at least 24 hours after concrete placement. Check completed formwork for grade and alignment to following tolerances:

Top of forms not more than 1/8" in 10'.

Vertical face on longitudinal axis, not more than 1/4" in 10'.

Clean forms after each use, and coat with form release agent as often as required to ensure separation from concrete without damage.

3.3 CONCRETE PLACEMENT:

3.3.1 General: Comply with requirements of ACI 318 for mixing and placing concrete, and as herein specified. Do not place concrete until subbase and forms have been checked for line and grade. Moisten subbase if required to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment. Use bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces. Deposit and spread concrete in a continuous operation between transverse joints, as far as possible. If interrupted for more than 1/2 hour, place a construction joint. Vibrate all concrete in place to assure proper consolidation.

3.3.2 Curbs and Gutters: Automatic machine may be used for curb and gutter placement at Contractor's option. If machine placement is to be used, submit revised mix design and laboratory test results that meet or exceed minimums specified. Machine placement must produce curbs and gutters to required cross-section, lines, grades, finish, and jointing as specified for formed concrete. If results are not acceptable, remove and replace with formed concrete as specified.

3.4 JOINTS

3.4.1 General: Construct expansion, weakened-plane (contraction), and construction joints true-to-line with face perpendicular to surface of concrete. Construct transverse joints at right angles to the centerline, unless otherwise indicated. When jointing existing structures, place transverse joints to align with previously placed joints, unless otherwise indicated. Joints in sidewalks shall be spaced 5 feet on center. Joints in cubs or pavements shall be a minimum 15 feet on center.

3.4.2 Weakened-Plane (Contraction) Joints: Provide weakened-plane (contraction) joints to a depth equal of at least 1/4 concrete thickness, as follows:

Tooled Joints: Form weakened-plane joints in fresh concrete by grooving top portion with a cutting tool and finishing edges with a jointer.

Sawed Joints: Form weakened-plane joints using powered saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut joints into hardened concrete as soon as surface will not be torn, abraded, or otherwise damaged by cutting action.

Inserts: Use embedded strips of metal or sealed wood to form weakened-plane joints. Set strips into plastic concrete and carefully remove strips after concrete has hardened.

3.4.3 Construction Joints: Place construction joints at end of placements and at locations where placement operations are stopped for a period of more than 1/2 hour, except where such placements terminate at expansion joints.

3.4.4 Expansion Joints: Provide premolded joint filler for expansion joints abutting concrete curbs, catch basins, manholes, inlets, structures, walks and other fixed objects, unless otherwise indicated. Locate expansion joints at 50' o.c. unless otherwise indicated. Extend joint fillers full-width and depth of joint, and not less than 1/2" or more than 1" below finished surface where joint sealer is indicated. If no joint sealer, place top of joint filler flush with finished concrete surface. Furnish joint fillers in one-piece lengths for full width being placed.

3.4.5 Fillers and Sealants: Prior to filling or sealing, remove all foreign material from joints and pavement. Apply fillers and sealers in accordance with the manufacturer's recommendations.

3.5 CONCRETE FINISHING: After striking-off and consolidating concrete, smooth surface by screeding and floating. Use hand methods only where mechanical floating is not possible. Adjust floating to compact surface and produce uniform texture. Distribute concrete as required to remove surface irregularities, and refloat repaired areas to provide a continuous smooth finish. Work edges of slabs, gutters, back top edge of curb, and formed joints with an edging tool, and round to 1/2" radius, unless otherwise indicated. Eliminate tool marks on concrete surface. After completion of floating and troweling when excess moisture or surface sheen has disappeared, complete surface finishing, as follows:

Broom finish, by drawing a fine-hair broom across concrete surface, perpendicular to line of traffic. Repeat operation if required to provide a fine line texture.

Burlap finish, by dragging a seamless strip of damp burlap across concrete, perpendicular to line of traffic. Repeat operation to provide a gritty texture.

Do not remove forms for 24 hours after concrete has been placed. After form removal, clean ends of joints and point-up any minor honeycombed areas. Remove and replace areas or sections with major defects, as directed by Engineer.

3.6 CURING: Protect and cure finished concrete paving, complying with applicable requirements of ACI 318. Use membrane-forming curing and sealing compound or approved moist-curing methods.

3.7 REPAIRS AND PROTECTIONS

3.7.1 Repair and replace broken or defective concrete. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur. Sweep concrete pavement and wash free of stains, discolorations, dirt and other foreign material just prior to final inspection.

3.7.2 Drill test cores where directed by Engineer, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.

END OF SECTION 321613

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SECTION 323119 - DECORATIVE METAL FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Decorative aluminum picket fences.
2. Decorative aluminum picket pedestrian gates.
3. Decorative aluminum infill panel fences.
4. Decorative aluminum infill panel pedestrian gates.
5. Decorative aluminum infill panel divider rail at entry.
6. Aluminum turnstile.
7. Decorative aluminum picket horizontal-slide gates.
8. Gate operators.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for concrete bases for gate operators, drives, and controls and post concrete fill.
2. Section 281500 "Integrated Access Control Hardware Devices" for access control devices installed at gates and provided as part of a security system.
3. Division 26 Sections for electrical service and connections for system disconnect switches and powered devices including, but not limited to, motor operators, controls, and limit switches.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Shop Drawings: For fencing and gates.

1. Include plans, elevations, sections, gate locations, post spacing, and mounting attachment details, and grounding details.
2. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
3. Wiring Diagrams: Include diagrams for power, signal, and control wiring.

C. Samples: For each fence material and for each color specified.

1. Provide Samples 12 inches in length for linear materials.
2. Provide Samples 12 inches square for bar grating and sheet or plate materials.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Product Test Reports: For decorative metallic-coated-steel tubular picket fences, including finish, indicating compliance with referenced standards and other specified requirements.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For gate operators to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Include 10 ft. length of fence complying with requirements.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Lightning-Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

2.2 TURNSTILE w/ ADA GATE

A. Basis of Design, Decorative Aluminum Fence Assembly: Fences made from aluminum extrusions.
   a. Manufacturer: Boon Edam, or approved equal.
   b. Model: Turnlock 150
   c. Material: Clear Anodized Aluminum
   d. Power: 110 VAC, Single Phase, 15A Mains Service
   e. Electronically Controlled; Two directions
   f. ADA Gate: Requires Turnlock 150 ADA Gate with panic bar

2.3 DECORATIVE ALUMINUM FENCES

A. Basis of Design, Decorative Aluminum Fence Assembly: Fences made from aluminum extrusions.
   a. Manufacturer: Ameristar Fence Products, or approved equal.
   b. Model: Echelon for gate material.
   c. Color: Black

B. Posts: Square extruded tubes.

1. Line Posts: as indicated on drawings.

2. End and Corner Posts: as indicated on drawings.

C. Rails: Extruded-aluminum channels, as indicated on drawings.

D. Pickets: Extruded-aluminum tubes, as indicated on drawings.

E. Fasteners:

1. Manufacturer's standard concealed fastening system.
2. Manufacturer's standard corrosion-resistant, color-coated fasteners matching fence components with resilient polymer washers.

F. Fabrication: Assemble fences into sections by fastening pickets to rails.

1. Fabricate sections with clips welded to rails for field fastening to posts.
2. Drill clips for fasteners before finishing.

G. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay.

H. Finish Coating: Baked enamel or powder coating.

2.4 ALUMINUM PANEL INFILL FENCE/ RAIL

A. Basis of Design; Gate Infill: As indicated on Drawings.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Greco Aluminum Panel Rail or comparable product by one of the following:
2. Manufacturer: Greco Architectural Metal Products
3. Model: Panel Infill Railing G506A

B. Posts: Square extruded tubes.

1. Line Posts: as indicated on drawings.

2. End and Corner Posts: as indicated on drawings.

C. Rails: Extruded-aluminum channels, as indicated on drawings.

D. Pickets: Extruded-aluminum tubes, as indicated on drawings.

E. Fasteners:

1. Manufacturer's standard concealed fastening system.
2. Manufacturer's standard corrosion-resistant, color-coated fasteners matching fence components with resilient polymer washers.

F. Fabrication: Assemble fences into sections by fastening pickets to rails.

1. Fabricate sections with clips welded to rails for field fastening to posts.

2. Drill clips for fasteners before finishing.

G. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay.

H. Finish Coating: Baked enamel or powder coating.

2.5 SWING GATES – ALUMINUM PICKET FENCE

A. Gate Configuration: Single leaf and Double leaf, as indicated on Drawings.

B. Gate Frame Height: As indicated on Drawings.

C. Gate Opening Width: As indicated on Drawings.

D. Galvanized-Steel Frames and Bracing: Fabricate members from square tubing, per manufacturer requirements.

E. Frame Corner Construction:

F. Welded frame with panels assembled with bolted or riveted corner fittings and truss rods for panels of a determined width or greater as required by manufacturer. Additional Rails: Provide as indicated, complying with requirements for fence rails.

G. Gate Infill: As indicated on Drawings.
   a. Manufacturer: Ameristar Fence Products, or approved equal.
   b. Model: Echelon for gate material.

H. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 5 ft. wide. Provide center gate stops and cane bolts for pairs of gates. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.

I. Hinges: BHMA A156.1, Grade 1, suitable for exterior use.

   1. Function: 39 - Full surface, triple weight, antifriction bearing.
   2. Material: Wrought steel, forged steel, cast steel, or malleable iron; galvanized.
   3.

J. Cane Bolts: Provide for inactive leaf of pairs of gates. Fabricated from 3/4-inch diameter round steel bars, hot-dip galvanized after fabrication. Finish to match gates. Provide galvanized-steel pipe strikes to receive cane bolts in both open and closed positions.

K. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay

L. Galvanizing: For items other than hardware that are indicated to be galvanized, hot-dip galvanize to comply with ASTM A123/A123M. For hardware items, hot-dip galvanize to comply with ASTM A153/A153M.

M. Metallic-Coated-Steel Finish: High-performance coating.

N. Steel Finish: High-performance coating.

2.6 SWING GATES – ALUMINUM PANEL INFILL FENCE

A. Gate Configuration: Single leaf and Double leaf, as indicated on Drawings.

B. Gate Frame Height: As indicated on Drawings.

C. Gate Opening Width: As indicated on Drawings.

D. Galvanized-Steel Frames and Bracing: Fabricate members from square tubing, per manufacturer requirements.

E. Frame Corner Construction:

F. Welded frame with panels assembled with bolted or riveted corner fittings and truss rods for panels of a determined width or greater as required by manufacturer. Additional Rails: Provide as indicated, complying with requirements for fence rails.

G. Gate Infill: As indicated on Drawings.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Greco Aluminum Panel Rail or comparable product by one of the following:
2. Manufacturer: Greco Architectural Metal Products
3. Model: Panel Infill Railing G506A

H. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 5 ft. wide. Provide center gate stops and cane bolts for pairs of gates. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.

I. Hinges: BHMA A156.1, Grade 1, suitable for exterior use.

1. Function: 39 - Full surface, triple weight, antifriction bearing.
2. Material: Wrought steel, forged steel, cast steel, or malleable iron; galvanized.
3.

J. Cane Bolts: Provide for inactive leaf of pairs of gates. Fabricated from 3/4-inch diameter round steel bars, hot-dip galvanized after fabrication. Finish to match gates. Provide galvanized-steel pipe strikes to receive cane bolts in both open and closed positions.

K. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay

L. Galvanizing: For items other than hardware that are indicated to be galvanized, hot-dip galvanize to comply with ASTM A123/A123M. For hardware items, hot-dip galvanize to comply with ASTM A153/A153M.

M. Metallic-Coated-Steel Finish: High-performance coating.

N. Steel Finish: High-performance coating.

2.7 OPERATED HORIZONTAL-SLIDE GATES

1. Manufacturers: Subject to compliance with requirements, provide the following products:
   a. Manufacturer: Ameristar Fence Products, or approved equal.
   b. Model: Echelon for gate material.
   c. Fence Height: As indicated in drawings.
   d. Gate Height: As indicated in drawings.
   e. Gate Width: As indicated in drawings.

B. Gate Configuration: Single leaf and Double leaf; as indicated in drawings.

1. Type: Cantilevered track assembly.

C. Gate Frame Height: As indicated in drawings.

D. Gate Opening Width: As indicated in drawings.

E. Automated vehicular gates shall comply with ASTM F 2200.

F. Galvanized-Steel Frames and Bracing: Fabricate members from square tubing, per manufacturer requirements.

G. Frame Corner Construction:

1. Welded frame with panels assembled with bolted or riveted corner fittings and truss rods for panels of a determined width or greater as required by manufacturer.

H. Additional Rails: Provide as indicated, complying with requirements for fence rails.

I. Infill: Comply with requirements for adjacent fence.

J. On Grade Track Assembly: Manufacturer's standard track, with overhead framing supports, bracing, and accessories, engineered to support size, weight, width, operation, and design of gate and roller assemblies.

K. Hardware: Latches permitting operation from both sides of gate, locking devices, roller assemblies and stops fabricated from galvanized steel. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.

1. All gates are to pad-lockable; coordinate key system with Owner and Architect.

L. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay

M. Metallic-Coated-Steel Finish: High-performance coating

2.8 OPERATED SWING GATES

1. Manufacturers: Subject to compliance with requirements, provide the following products:
   a. Manufacturer: Ameristar Fence Products, or approved equal.
   b. Model: Echelon for gate material.
   c. Fence Height: As indicated in drawings.
   d. Gate Height: As indicated in drawings.
   e. Gate Width: As indicated in drawings.

B. Gate Configuration: Single leaf and Double leaf; as indicated in drawings.

1. Type: Cantilever slide, with external roller assemblies.

C. Gate Frame Height: As indicated in drawings.

D. Gate Opening Width: As indicated in drawings.

E. Automated vehicular gates shall comply with ASTM F2200.

F. Galvanized-Steel Frames and Bracing: Fabricate members from square tubing, per manufacturer requirements.

G. Frame Corner Construction:

1. Welded frame with panels assembled with bolted or riveted corner fittings and truss rods for panels of a determined width or greater as required by manufacturer.

H. Additional Rails: Provide as indicated, complying with requirements for fence rails.

I. Infill: Comply with requirements for adjacent fence.

J. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 5 feet wide. Provide center gate stops and cane bolts for pairs of gates. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.

1. Locking to be coordinated with building user group.

K. Hinges: BHMA A156.1, Grade 1, suitable for exterior use.

1. Function: 39 - Full surface, triple weight, antifriction bearing.
2. Material: Wrought steel, forged steel, cast steel, or malleable iron; galvanized.

L. Exit Hardware: BHMA A156.3, Grade 1, Type 1 (rim exit device), with push pad actuating bar, suitable for exterior use. Refer to Electrical Specifications for specific requirements.

M. Cane Bolts: Provide for inactive leaf of pairs of gates. Fabricated from 3/4-inch- diameter, round steel bars, hot-dip galvanized after fabrication. Finish to match gates. Provide galvanized-steel pipe strikes to receive cane bolts in both open and closed positions.

N. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay

O. Metallic-Coated-Steel Finish: High-performance coating

2.9 GATE OPERATORS

A. Gate Operators:

1. Manufacturers: Subject to compliance with requirements, provide the following products; typically one separate operator per gate.
   a. Manufacturer: Ameristar Gate Systems, or approved equal.
   b. Model: 9150 AGS Vehicular

c. Horsepower: Not less than 1 HP; confirm adequate operator power to function all gates (gate widths vary; therefore, gate weights will vary).
d. Operator Location: As indicated in drawings; location with respect to be fence as required by manufacturer specifications and recommendations.

B. Provide factory-assembled automatic operating system designed for gate size, type, weight, and operation frequency. Provide operation control system with characteristics suitable for Project conditions, with remote-control stations, safety devices, and weatherproof enclosures; coordinate electrical requirements with building electrical system.

1. Provide operator designed so motor may be removed without disturbing limit-switch adjustment and without affecting auxiliary emergency operator.
2. Provide operator with UL approval. Provide electronic components with built-in troubleshooting diagnostic feature.
3. Provide unit designed and wired for both right-hand/left-hand opening, permitting universal installation.

C. Comply with NFPA 70.

D. UL Standard: Manufacturer and label gate operators to comply with UL 325.

E. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for automatic gate operators on gates that must provide emergency access.
1. Gates must be siren activated where indicated on drawings.

F. Motor Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, within installed environment, with indicated operating sequence, and without exceeding nameplate rating or considering service factor. Comply with NEMA MG 1 and the following:

G. Gate Operators: Concrete base mounted and as follows:

H. Remote Controls: Electric controls separated from gate and motor and drive mechanism, with [NEMA ICS 6, Type 1] [NEMA ICS 6, Type 4] concrete base mounting, and with space for additional optional equipment. Provide the following remote-control device(s):

a. As indicated on security drawings.

I. Vehicle Loop Detector: System includes automatic closing timer with adjustable time delay, timer cutoff switch, and loop detector designed to open and close gate, hold gate open until traffic clears,and reverse gate. System includes electronic detector with adjustable detection patterns, adjustable sensitivity and frequency settings, and panel indicator light designed to detect presence or transit of a vehicle over an embedded loop of wire and to emit a signal activating the gate operator. System includes number of loops consisting of multiple strands of wire, number of turns, loop size, and method of placement, as recommended in writing by detection system manufacturer for function indicated, at location shown on Drawings.

J. Vehicle Presence Detector: System includes automatic closing timer with adjustable time delay, timer cutoff switch, and presence detector designed to open and close gate and hold gate open until traffic clears, and reverse gate. System includes [retroreflective] [emitter/receiver] detector with adjustable detection zone pattern and sensitivity, designed to detect the presence or transit of a vehicle in gate pathway when infrared beam in zone pattern is interrupted, and to emit a signal activating the gate operator.

K. Obstruction Detection Devices: Provide each motorized gate with automatic safety sensor(s). Activation of sensor(s) causes operator to immediately function as follows:

1. Action: Reverse gate in both opening and closing cycles, and hold until clear of obstruction.
2. Action: Stop gate in opening cycle and reverse gate in closing cycle, and hold until clear of obstruction.
3. Internal Sensor: Built-in torque or current monitor senses gate is obstructed.
4. Sensor Edge: Contact-pressure-sensitive safety edge, profile, and sensitivity designed for type of gate and component indicated, in locations as follows. Connect to control circuit using gate edge transmitter and operator receiver system.

    a. Along entire gate leaf leading edge.
    b. Along entire gate leaf trailing edge.
    c. Across entire gate leaf bottom edge.
    d. Along entire length of gate posts.
    e. Along entire length of gate guide posts.
    f. Where indicated on Drawings.

5. Photoelectric/Infrared Sensor System: Designed to detect an obstruction in gate's path when infrared beam in the zone pattern is interrupted.

L. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop gate at fully retracted and fully extended positions.

M. Emergency Release Mechanism: Quick-disconnect release of operator drive system of the following type, permitting manual operation if operator fails. Design system so control-circuit power is disconnected during manual operation.

1. Type: Integral fail-safe release, allowing gate to be pushed open without mechanical devices, cranks, or special knowledge; key will be required to push open gate.

N. Operating Features:

1. Digital Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features with capability for monitoring and auditing gate activity. Provide unit that is isolated from voltage spikes and surges.
2. System Integration: With controlling circuit board capable of accepting any type of input from external devices.
3. Master/Slave Capability: Control stations designed and wired for gate pair operation.
4. Automatic Closing Timer: With adjustable time delay before closing and timer cutoff switch.
5. Open Override Circuit: Designed to override closing commands.
6. Reversal Time Delay: Designed to protect gate system from shock load on reversal in both directions.
7. Maximum Run Timer: Designed to prevent damage to gate system by shutting down system if normal time to open gate is exceeded.
8. Clock Timer: 24-hour, Seven-day programmable for regular events.

O. Accessories:

1. Warning Module: Audio and Visual, constantlight alarm sounding three to five seconds in advance of gate operation and continuing until gate stops moving; compliant with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.

2. Battery Backup System: Battery-powered drive and access-control system, independent of primary drive system:

    a. Fail-Safe: Gate opens and remains open until power is restored.
    b. Fail-Secure: Gate cycles on battery power, then fail-safe when battery is discharged.

3. External electric-powered [solenoid] [magnetic] lock with delay timer allowing time for lock to release before gate operates.
4. Fire box; Knox Box as indicated on drawings.
5. Fire siren sensor.
6. Instructional, Safety, and Warning Labels and Signs: According to UL 325.
7. Equipment Bases/Pads: Precast concrete, dimensioned and reinforced according to gate operator component manufacturer's written instructions and as indicated on Drawings.

2.10 STEEL AND IRON MATERIALS

A. Plates, Shapes, and Bars: ASTM A36/A36M.

B. Tubing: ASTM A500/A500M, cold-formed steel tubing.

C. Uncoated Steel Sheet: Hot-rolled steel sheet, ASTM A 1011/A 1011M, Structural Steel, Grade 45 or cold-rolled steel sheet, ASTM A 1008/A 1008M, Structural Steel, Grade 50

1. Interior surface of tubes formed from uncoated steel sheet shall be hot-dip zinc coated same as exterior.

A. Galvanized-Steel Sheet: ASTM A 653/A 653M, structural quality, G60 coating.

A. Aluminum-Zinc, Alloy-Coated Steel Sheet: ASTM A 792/A 792M, structural quality, Grade 50 with AZ60 coating.

B. Castings: Either gray or malleable iron unless otherwise indicated on Drawings.

1. Gray Iron: ASTM A48/A48M, Class 30.
2. Malleable Iron: ASTM A47/A47M.

2.11 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

1. For aluminum, provide type and alloy as recommended by producer of metal to be welded and as required for strength and compatibility in fabricated items.

B. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 033000 "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi 3-inch slump, and 1-inch maximum aggregate size or dry, packaged, normal-weight concrete mix complying with ASTM C 387/C 387M mixed with potable water according to manufacturer's written instructions.

C. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M and specifically recommended by manufacturer for exterior applications.

2.12 GROUNDING MATERIALS

A. Grounding Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.

1. Material above Finished Grade: Copper or Aluminum, as required by manufacturer.
2. Material on or below Finished Grade: Copper.
3. Bonding Jumpers: Braided copper tape, 1 inch wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.

B. Grounding Connectors and Grounding Rods: Comply with UL 467.

1. Connectors for Below-Grade Use: Exothermic-welded type.
2. Grounding Rods: Copper-clad steel.

a. Size: 5/8 by 96 inches

2.13 STEEL FINISHES

A. Surface Preparation: Clean surfaces in accordance with [SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning."] [SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."] After cleaning, apply a conversion coating compatible with the organic coating to be applied over it.

B. Primer Application: Apply zinc-rich epoxy primer immediately after cleaning, to provide a minimum dry film thickness of 2 mils per applied coat, to surfaces that are exposed after assembly and installation, and to concealed surfaces.

C. Shop-Painted Finish: Comply with [Section 099113 "Exterior Painting."] [Section 099600 "High-Performance Coatings."]

D. High-Performance Coating: Apply intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended in writing by coating manufacturer.

1. Match approved Samples for color, texture, and coverage. Remove and refinish, or recoat work that does not comply with specified requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.

B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 ft. or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

1. Construction layout and field engineering are specified in Section 017300 "Execution."

3.3 INSTALLATION OF DECORATIVE FENCES

A. Install fences in accordance with manufacturer's written instructions.

B. Install fences by setting posts as indicated on Drawings and fastening rails and infill panels to posts.

C. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth of not less than 24 inches plus 3 inches for each foot or fraction of a foot that fence height exceeds 4 ft..

D. Post Setting: Set posts [in concrete] [with mechanical anchors] [by mechanically driving into soil] at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around [posts] [and] [sleeves] and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

    a. Exposed Concrete: Extend 2 inches above grade. Finish and slope top surface to drain water away from post. Condition applies to fences within hardscape.
    b. Concealed Concrete: Top 2 inches below grade or as otherwise indicated on Drawings to allow covering with surface material. Slope top surface of concrete to drain water away from post. Condition applies to fences within landscape.

3. Posts Set in Concrete: Extend post to within 6 inches of specified excavation depth, but not closer than 3 inches to bottom of concrete.
4. Posts Set into Concrete in Sleeves: Use galvanized-steel pipe sleeves with inside diameter at least 3/4 inch larger than outside diagonal dimension of post, preset and anchored into concrete for installing posts.

    a. Extend posts at least 5 inches into sleeve.
    b. After posts have been inserted in sleeves, fill annular space between post and sleeve with nonshrink grout, mixed and placed to comply with grout manufacturer's written instructions; shape and smooth to shed water. Finish and slope top surface of grout to drain water away from post.

5. Posts Set into Voids in Concrete: Form or core drill holes not less than 3/4 inch larger than outside diagonal dimension of post.

a. Extend posts at least 5 inches into concrete.
b. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink grout, mixed and placed to comply with grout manufacturer's written instructions. Finish and slope top surface of grout to drain water away from post.

6. Mechanically Driven Posts: Drive into soil to depth of dimension as indicated on shop drawings.
7. Space posts uniformly as indicated on drawings.

3.4 INSTALLATION OF GATES

A. Install gates in accordance with manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.5 INSTALLATION OF GATE OPERATORS

A. General: Install gate operators in accordance with manufacturer's written instructions, aligned and true to fence line and grade.

B. Excavation: Hand-excavate holes for support posts, pedestals,concrete bases in firm, undisturbed soil to dimensions and depths and at locations as required by gate operator component manufacturer's written instructions and as indicated on Drawings.

C. Concrete Bases: Cast-in-place or precast concrete, dimensioned and reinforced in accordance with gate operator component manufacturer's written instructions and as indicated on Manufacturer Shop Drawings.

D. Vehicle-Sensing System: Cut grooves in pavement and bury and seal wire loop in accordance with manufacturer's written instructions. Connect to equipment operated by detector.

E. Comply with NFPA 70 and manufacturer's written instructions for grounding of electric-powered motors, controls, and other devices.

3.6 GROUNDING AND BONDING

A. Comply with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Fence Grounding: Install at maximum intervals of 1500 ft.

1. Fences within 100 Ft. (30 m) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 ft.

a. Gates and Other Fence Openings: Ground fence on each side of opening.

1) Bond metal gates to gate posts.
2) Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches below finished grade.

C. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 ft. on each side of crossing.

D. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.

E. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

F. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

G. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

H. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

1. Grounding-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance not less than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method in accordance with IEEE 81.
2. Excessive Grounding Resistance: If resistance to grounding exceeds specified value, notify Architect promptly. Include recommendations for reducing grounding resistance and a proposal to accomplish recommended work.
3. Report: Prepare test reports of grounding resistance at each test location certified by a testing agency. Include observations of weather and other phenomena that may affect test results.

3.8 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Automatic Gate Operators: Energize circuits to electrical equipment and devices. Adjust operators, controls, safety devices, alarms, and limit switches.

1. Hydraulic Operators: Purge operating system, adjust pressure and fluid levels, and check for leaks.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls, alarms, and safeties. Replace damaged and malfunctioning controls and equipment.

C. Lubricate hardware, gate operators, and other moving parts.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain gates.

END OF SECTION 323119

SECTION 323300 - SITE FURNISHINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Benches.
   2. Trash/ Recycle Receptacles.
   3. Bicycle racks.
   4. Bollards.
   5. Planter Bed Guardrail.
   6. Removable Stanchions.

B. Related Requirements:

   1. Section 033000 "Cast-in-Place Concrete" for installing pipe sleeves cast and installing anchor bolts cast in concrete footings.
   2. Section 312000 "Earth Moving" for excavation for installing concrete footings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified.

C. Samples for Initial Selection: For units with factory-applied finishes.

D. Samples for Verification: For each type of exposed finish, not less than 6-inch long linear components and 4-inch- square sheet components.

E. Product Schedule: For site furnishings. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates: For site furnishings manufactured with preservative-treated wood.

   1. Indicate type of preservative used and net amount of preservative retained. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1 1.5 CLOSEOUT SUBMITTALS

2 A. Maintenance Data: For site furnishings to include in maintenance manuals.

3 1.6 MAINTENANCE MATERIAL SUBMITTALS

4 A. Furnish extra materials that match products installed and that are packaged with protective
5 covering for storage and identified with labels describing contents.

6 1. Bench Replacement Slats No fewer than two full-size units for each size indicated.

7 PART 2 - PRODUCTS

8 2.1 BENCHES

9 A. Basis of Design: (Or Approved Equal)
10 1. Manufacturer: Forms + Surfaces
11 2. Model: Trio
12 3. Slat Texture: Argento

13 B. Frame: Aluminum.

14 C. Aluminum Finish: Powder coated.

15 1. Color: Silver, selected from manufacturer full range of standard color options.

16 D. Design.

17 1. Length: 6’ length and 8’ length, as noted on drawings.

18 2. Arms: Ends only, no intermediate arms.

19 3. Back: Includes back

20 4. Install: Anchor bolted in place.

21 2.2 TRASH/ RECYCLE RECEPTACLES

22 A. Basis of Design: (Or Approved Equal)
23 1. Manufacturer: Forms + Surfaces
24 2. Model: Tonyo
25 3. Slate + Argento Texture

26 B. Frame: Aluminum.

27 C. Aluminum Finish: Powder coated.

28 1. Color: Silver, selected from manufacturer full range of standard color options.

29 D. Design.

1. Capacity: 36 gallons

2. Design Requirements: Single Stream with Rain Cover.

3. Access: Standard Lift, Latch.

4. Install: Anchor bolted in place.

2.3 BIKE RACKS

A. Basis of Design: (Or Approved Equal)
   1. Manufacturer: Landscape Forms
   2. Model: Loop

B. Frame: Aluminum.

C. Aluminum Finish: Powder coated.

   1. Color: Silver, selected from manufacturer full range of standard color options.

2.4 BOLLARDS

A. Basis of Design: (Or Approved Equal)
   1. Manufacturer: Forms + Surfaces
   2. Model: Aptos

B. Frame: Aluminum.

C. Aluminum Finish: Powder coated.

   1. Color: Silver, selected from manufacturer full range of standard color options.

D. Lighting: Bollard is to be lit, hardwired power source.

2.5 PLANTER BED GUARDRAIL

A. Dimensions and Design: Refer to Detail Drawings.

B. Frame Material/ Finish: Anodized Aluminum.

A. Rail Material/ Finish: Anodized Aluminum.

B. Mounting: Embed Mount.

2.6 REMOVABLE STANCHIONS

A. Basis of Design: (Or Approved Equal)
   1. Manufacturer: Queuepro

2. Model: Twin 250 Removable

B. Frame: Stainless Steel.

C. Stainless Steel Finish: Satin.

D. Height: 40 Inches

E. Post OD: 2.5”

F. Base OD: 5”

G. Belt Width: 2”

H. Belt Length: 13’, Retractable

I. Belt Color: Black.

2.7 MATERIALS

A. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated; free of surface blemishes and complying with the following:

1. Rolled or Cold-Finished Bars, Rods, and Wire: ASTM B 211.
2. Extruded Bars, Rods, Wire, Profiles, and Tubes: ASTM B 221.
3. Structural Pipe and Tube: ASTM B 429/B 429M.
4. Sheet and Plate: ASTM B 209.
5. Castings: ASTM B 26/B 26M.

B. Stainless Steel: Free of surface blemishes and complying with the following:

1. Sheet, Strip, Plate, and Flat Bars: ASTM A 666.
2. Pipe: Schedule 40 steel pipe complying with ASTM A 312/A 312M.
3. Tubing: ASTM A 554.

C. Anchors, Fasteners, Fittings, and Hardware: Stainless steel commercial quality, installed per detail drawings.

D. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M; recommended in writing by manufacturer, for exterior applications.

E. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound; resistant to erosion from water exposure without needing protection by a sealer or waterproof coating; recommended in writing by manufacturer, for exterior applications.

F. Galvanizing: Where indicated for steel and iron components, provide the following protective zinc coating applied to components after fabrication:

1. Zinc-Coated Tubing: External, zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. of zinc after welding, a chromate conversion coating, and a clear, polymer film.

Internal, same as external or consisting of 81 percent zinc pigmented coating, not less than 0.3 mil thick.

2. Hot-Dip Galvanizing: According to ASTM A 123/A 123M, ASTM A 153/A 153M, or ASTM A 924/A 924M.

2.8 FABRICATION

A. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.

B. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections, finish surfaces smooth and blended, so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.

C. Pipes and Tubes: Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.

D. Preservative-Treated Wood Components: Complete fabrication of treated items before treatment if possible. If cut after treatment, apply field treatment complying with AWPA M4 to cut surfaces.

E. Exposed Surfaces: Polished, sanded, or otherwise finished; all surfaces smooth, free of burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.

F. Factory Assembly: Factory assemble components to greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.

2.9 GENERAL FINISH REQUIREMENTS

A. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.10 ALUMINUM FINISHES

A. Powder-Coat Finish: Manufacturer's standard polyester powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

2.11 STAINLESS-STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run directional finishes with long dimension of each piece.
2. Directional Satin Finish: No 4.

3. Dull Satin Finish: No. 6.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.

B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.

C. Install site furnishings level, plumb, true, and securely anchored and positioned at locations indicated on Drawings.

D. Post Setting: Set cast-in support posts in concrete footing with smooth top, shaped to shed water. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at correct angle and are aligned and at correct height and spacing. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.

E. Posts Set into Voids in Concrete: Form or core-drill holes for installing posts in concrete to depth recommended in writing by manufacturer of site furnishings and 3/4 inch larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

F. Pipe Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

END OF SECTION 323300

SECTION 328400 - PLANTING IRRIGATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section. See other Specification Sections:

1. 012100 – Allowances
2. 22113 – Facility Water Distribution Piping

1.2 SUMMARY

A. The Drawings and Specifications herein apply to the Point of Connection and downs stream.

B. Section Includes:

1. Piping.
2. Encasement for piping.
3. Manual valves.
4. Pressure-reducing valves.
5. Automatic control valves.
6. Automatic drain valves.
7. Transition fittings.
8. Dielectric fittings.
9. Miscellaneous piping specialties.
10. Sprinklers.
11. Quick couplers.
12. Drip irrigation specialties.
13. Controllers.
14. Boxes for automatic control valves.

1.3 DEFINITIONS

A. Irrigation Supply: Upstream of the Point of Connection, the irrigation supply includes the back flow preventer, the meter, feeds and taps.

B. Point of Connection: Defined as the below ground discharge from the backflow preventer.

C. Irrigation System: Defined as components of the system that are located immediately downstream of the point of connection. See Engineering drawings and specifications for upstream portions of the system

D. Drain Piping: Downstream from circuit-piping drain valves. Piping is not under pressure.

E. System Main Feed – The piping and fittings required to move water from the Point of Connection to 5' beyond the Main Isolation Valve

F. Main Isolation Valve – A master valve capable of shutting off the entire system before the system main splits - as located on the plan.

G. Main Piping: Downstream from point of connection to water distribution piping to, and including, control valves. Piping is under water-distribution-system pressure.

H. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4.1 PERFORMANCE REQUIREMENTS

A. This Section describes work downstream of the Irrigation Supply (backflow device). See Division 22 Section "Facility Water Distribution Piping" for taps, meter, and backflow device.
   1. Follow NC General Statute 143-355.4 for separate meters and taps for irrigation systems.

B. The design must meet the following design guidelines:
   1. Requirements supplied by local municipalities

C. Pressure – The Contractor is responsible for delivering a system capable of delivering working pressures to the equipment that are according to the manufacturer's recommendations.

D. Irrigation zone control shall be automatic operation with controller and automatic control valves.

E. High rate delivery systems such as flood bubblers are not allowed.

F. Provide only high efficiency equipment capable of providing water accurately and efficiently. The system shall use drip irrigation for plants and spray for turf.

G. Provide an irrigation system that completely separates lawn irrigation from shrub irrigation. Maintain 100 percent head to head irrigation coverage of areas indicated.

H. No main piping or control wiring shall be located outside property lines or within road right of ways. Other system components may be allowed by the local municipality.

I. Location of Sprinklers and Specialties: Design location is approximate. Make minor adjustments necessary to avoid plantings and obstructions such as signs and lights.

J. No valves, fittings, or joints are to be placed under paved surfaces, curbs or sidewalks. Where possible, crossing shall be uninterrupted stretches of pipe within sleeves sized according to the drawings.

K. Minimum Working Pressures: The following are minimum pressure requirements for piping, valves, and specialties unless otherwise indicated:

   1. Irrigation System Feed: 400 psig.
   2. Irrigation Main Piping and Circuit Piping: 200 psig.

L. The following are soil conditions found at the site:

a. Structure: The soil structure of the site is compacted due to working and construction activity. This compaction will reduce standard infiltration rates.

b. Infiltration Rate:

1) Sandy loam: .5-.8 in/hr.
2) Clay loam: .4--.5 in/hr
3) Clay: .2-.3 in/hr.

Drip Emitters Per Plant – use the following guide to set the number of emitters per plant, based upon a 2 hour watering window [WW] and delivering matched water delivery per zone.

TABLE 1 – DRIP SYSTEM PERFORMANCE REQUIREMENTS

Type of plant	Plant Size at instal-lation	Gal. Per week [X]	Gal/ WW	Minimum # emit-ters per plant	# emit-ters per plant at .5 gph	# emit-ters per plant at 1.0 gph	# emitters per plant at 1.5 gph	# emitters per plant at 2.0 gph	# emit-ters per plant at 3.0 gph
Tree	5-7” cali-per tree	100	7.1	6	14		5	4	2
	2.5” to 4” caliper	60	4.3	4	9	4	3	2	1
Shrub	8-10’ BB shrub	40	2.9	4	6	3	2	1	1
	5-7’ BB shrub	20	1.4	3	3	1	1	1	N/A
	3-6’ con-tainer shrub	10	0.7	2	2	2	N/A	N/A	N/A
	8” – 30” shrub or ground-cover	7	0.5	1	1	1	N/A	N/A	N/A
Grass es and Per-enni-als	Quart size plant	5	0.4	1	1	N/A	N/A	N/A	N/A
Plugs	4” pot and less	3		Grid of drip. See be-low					

- Minimum emitters per plant equals what is required to fully wet the root ball perimeter, not just one side
- Emitters should be placed 4-6” inside the root ball
- N/A – less than one emitter which is not possible
- Grid of drip should be the same rate as the plant spacing
- The Contractor shall use this table as a guide. Provide refinement of the system for different plant types and soil conditions.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Equipment Numbering System

C. Use a coordinated numbering system for shop drawings, as-builts and field labeling as follows:
   1. Turf Valves – Use 1-50
   2. Drip Valves – Use 51-99
   3. Valves, Pressure Regulators & Other Equipment - Use 100 and above

D. Delegated-Design Submittal [Shop Drawings]: The Contractor shall submit a shop drawing to verify the design provided by Landscape Architect. The Contractor must add information to the Landscape Architect design but may choose to redesign or modify the design indicated on the drawings to accommodate different equipment or technologies. All modifications to the design are subject to approval by the Landscape Architect. For irrigation systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional designer responsible for their preparation.

   1. Main piping
   2. Circuit piping
   3. Stream and spray rotors – with graphic radius indicated
   4. Automatic control valves
   5. Tap, backflow, and meter locations
   6. Time clock and rain sensor location
   7. Blow-off valves, isolation valves, quick coupler connections,
   8. Numbered valves with GPM requirements
   9. Coordination with site elements and utilities.
   10. Required Pressure at Point of Connection – The irrigation designer shall state the pressure required of irrigation system in PSI.
   11. System Pressure Loss – The designer shall state the calculated pressure loss from the Point of Connection to the furthest automated valve in PSI on the drawing.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. System Manual: A hard cover, 3 ring bound, exterior project titled, with table of contents for sprinklers, drip assemblies, controllers, pumps, quick couplers, rain sensors, and automatic control valves to include the following:
   1. Product cut sheets designating exact model number(s)
   2. Written schedule of operation including a winterization date, start-up date, and controller timing schedule suggestions for spring, summer, and fall.

3. Operation and Maintenance information of the provided equipment including a schedule of routine maintenance for cleaning and adjusting equipment.
4. Reduced as-built plans bound with in the manual or in plastic sleeves.

B. Prepare an as-built CAD drawing of the installed system. The drawings shall be legible with no overlapping or hidden graphics. Provide enlargements of crowded or obscured areas. Take field measurements and indicate on the drawings the dimensions of key elements from known site points such as the buildings and roadways to showing installed conditions of the following equipment:

1. Heads
2. Main lines and lateral lines
3. Automatic valves, manual valves, blow-offs and quick couplers
4. Tap, meter, backflow, time clock and rain sensor
5. Circuit and sensor wires
6. Valve numbers corresponding to the time clock labeling, zone designation, and GPM for each zone.

1.8 MATERIALS MAINTENANCE SUBMITTALS [ATTIC STOCK]

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Stream Rotors: Equal to 5% percent of amount installed for each type and size indicated, but no fewer than 5 units with filters and a selection of matching nozzles.
2. Spray Sprinklers: Equal to 5% percent of amount installed for each type and size indicated, but no fewer than 5 units with filters and a selection of nozzles.
3. Drip-Tube System Tubing: Equal to 2% percent of total length installed for each type and size indicated, but not less than 100 feet.
4. Drip emitters – provide 10 of each type.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Must be a licensed irrigation contractor in the State of North Carolina according to NC Irrigation Licensing Board.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.11 PROJECT CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Architect and Owner no fewer than two days in advance of proposed interruption of water service.
2. Do not proceed with interruption of water service without Owner's written permission.
3. Do not proceed with irrigation work until rough grade approval is given by the Landscape Architect.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Comply with requirements in the piping schedule for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes. Supply components having pressure rating equal to or greater than system operating pressure.

B. Underground irrigation System Main Feed shall be the following:
1. Schedule 80, PVC socket fittings; and solvent-cemented joints.

C. Underground irrigation Main Piping shall be the following:
1. SDR 200, PVC, pressure-rated pipe; Schedule 80, PVC socket fittings; and solvent-cemented joints.

D. Circuit piping shall be the following:
1. SDR 200, PVC, pressure-rated pipe; Schedule 40, PVC socket fittings; and solvent-cemented joints.

E. Risers to Aboveground drip lines: Schedule 80, PVC pipe and socket fittings; and solvent-cemented joints.

2.2 PIPING JOINING MATERIALS

A. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656. Use a color tinted material.

2.3 MANUAL VALVES

A. Brass Ball Valves:

1. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. DynaQuip Controls.
d. Flow-Tek, Inc.; a subsidiary of Bray International, Inc.

e. Hammond Valve.
f. Jamesbury; a subsidiary of Metso Automation.
g. Jomar International, LTD.
h. KITZ Corporation.
i. Legend Valve.
j. Marwin Valve; a division of Richards Industries.
k. Milwaukee Valve Company.
l. NIBCO INC.
m. Red-White Valve Corporation.
n. RuB Inc.

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded or solder joint if indicated.
g. Seats: PTFE or TFE.
h. Stem: Brass.
i. Ball: Chrome-plated brass.
j. Port: Full [not reduced].

B. Plastic Ball Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. American Valve, Inc.
b. Asahi/America, Inc.
c. Colonial Engineering, Inc.
d. Fischer, George Inc.
e. Hayward Flow Control Systems; Hayward Industrial Products, Inc.
f. IPEX Inc.
g. Jomar International, LTD.
h. KBI (King Bros. Industries).
i. Legend Valve.
j. NIBCO INC.
k. Sloane, George Fischer, Inc.
l. Spears Manufacturing Company.
m. Thermoplastic Valves Inc.
n. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-122.
b. Pressure Rating: 200 psig.
c. Body Material: PVC.
d. Type: Union.
e. End Connections: Socket or threaded.
f. Port: Full.

2.4 PRESSURE-REDUCING VALVES

A. Water Pressure Regulators:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Cash Acme; a division of The Reliance Worldwide Corporation.
    b. Conbraco Industries, Inc.; Apollo Valves.
    c. Honeywell International Inc.
    d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    e. Zurn Plumbing Products Group; Wilkins Water Control Products.

2. Description:

    a. Standard: ASSE 1003.
    b. Body Material: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved.
    c. Pressure Rating: Initial pressure of 150 psig.
    d. End Connections: Threaded for NPS 2 and smaller.

2.5 AUTOMATIC CONTROL VALVES

A. High Flow Plastic, automatic Control Valves for lawn sprinklers:

1. Description: Molded-plastic body, normally closed, diaphragm type with manual-flow adjustment, and operated by 24-V ac solenoid. For flow ranges from 5 to 100 gpm.

2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following::

    a. Buckner; a division of Storm Manufacturing Group Inc.
    b. Ceres Products Company.
    c. Champion Irrigation Products.
    d. Dig Corporation.
    e. Greenlawn Sprinkler Company.
    f. Hit Products Corporation.
    g. Hunter Industries Incorporated.
    h. Irritrol Systems.
    i. Nelson, L. R. Corporation.
    j. Netafim USA.
    k. Olson Irrigation Systems.
    l. Orbit Irrigation Products, Inc.
    m. Rain Bird Corporation.
    n. Superior Controls Co., Inc.
    o. Toro Company (The); Irrigation Division.
    p. Weathermatic.

B. Low Flow Drip Control Valves:

1. Description: Molded-plastic body, normally closed, diaphragm type with manual-flow adjustment, and operated by 24-V ac solenoid. For flow ranges below 5 gpm.

2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Buckner; a division of Storm Manufacturing Group Inc.
   b. Ceres Products Company.
   c. Champion Irrigation Products.
   d. Dig Corporation.
   e. Greenlawn Sprinkler Company.
   f. Hit Products Corporation.
   g. Hunter Industries Incorporated.
   h. Irritrol Systems.
   i. Nelson, L. R. Corporation.
   j. Netafim USA.
   k. Olson Irrigation Systems.
   l. Orbit Irrigation Products, Inc.
   m. Rain Bird Corporation.
   n. Superior Controls Co., Inc.
   o. Toro Company (The); Irrigation Division.
   p. Weathermatic.

2.6 AUTOMATIC DRAIN VALVES

A. Description: Spring-loaded-ball type of corrosion-resistant construction and designed to open for drainage if line pressure drops below 2-1/2 to 3 psig.

2.7 TRANSITION FITTINGS

A. General Requirements: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

B. Transition Couplings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Cascade Waterworks Manufacturing.
   b. Dresser, Inc.; DMD Division.
   c. Ford Meter Box Company, Inc. (The).
   d. JCM Industries.
   e. Smith-Blair, Inc; a Sensus company.
   f. Viking Johnson.

2. Description: AWWA C219, metal sleeve-type coupling for underground pressure piping.

C. Metal to Plastic Transition Fittings at Point of Connection:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Harvel Plastics, Inc.
    b. Spears Manufacturing Company.

2. Description: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-socket or threaded end.

2.8 MISCELLANEOUS PIPING SPECIALTIES

A. Water Hammer Arresters: ASSE 1010 or PDI WH 201, with bellows or piston-type pressurized cushioning chamber and in sizes complying with PDI WH 201, Sizes A to F.

B. Pressure Gages: ASME B40.1. Include 4-1/2-inch- diameter dial, dial range of two times system operating pressure, and bottom outlet.

C. Detectable Warning Tape: Provide detectable warning tape with “IRRIGATION LINE” clearly marked and a unique color.

2.9 SPRINKLERS

A. General Requirements: Designed for uniform coverage over entire spray area indicated at available water pressure.

B. Plastic, Pop-up, Gear-Drive Rotary Sprinklers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. IrritrolHunter Industries Incorporated
    b. Nelson, L. R. Corporation.
    c. Rain Bird Corporation.
    d. Toro Company (The); Irrigation Division.
    e. Weathermatic.
    f. Irritrol
    g. K-Rain

2. Description:

    a. Body Material: ABS.
    b. Nozzle: ABS.
    c. Retraction Spring: Stainless steel.
    d. Internal Parts: Corrosion resistant.

3. Capacities and Characteristics:

a. Flow: see plan – fit with nozzles to provide matched precipitation.
b. Pop-up Height: 4” aboveground to nozzle.
c. Spray Shapes: radial - full, three quarter, half, one quarter or adjustable], rectangle, strips.
d. Radius: see plan
e. Inlet: NPS 1/2.

C. Plastic, Pop-up Spray Sprinklers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Nelson, L. R. Corporation
b. Hunter Industries Incorporated.
c. Rain Bird Corporation.
d. Toro Company (The); Irrigation Division.
e. Weathermatic.

2. Description:

a. Body Material: ABS.
b. Nozzle: ABS.
c. Retraction Spring: Stainless steel.
d. Internal Parts: Corrosion resistant.
e. Pattern: Fixed, with flow adjustment.

3. Capacities and Characteristics:

a. Nozzle: ABS.
b. Flow: See plan
c. Pop-up Height: minimum 6” for lawns.
d. Arc: [full, three quarter, half, one quarter or adjustable], rectangle, strips.
e. Radius: see plan
f. Inlet: NPS 1/2.

2.10 QUICK COUPLERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Hunter Industries Incorporated.
2. Nelson, L. R. Corporation.
3. Rain Bird Corporation.
4. Toro Company (The); Irrigation Division.
5. Weathermatic.

B. Description: Factory-fabricated, bronze or brass, two-piece assembly. Include coupler water-seal valve; removable upper body with spring-loaded or weighted, rubber-covered cap;

C. Key – Provide factory-fabricated brass one piece swiveling connector with ASME B1.20.7, 3/4-11.5NH threads for garden hose on outlet. Provide one key per installed quick coupler with a minimum number of two.

2.11 RAIN SENSOR

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Hunter Industries Incorporated.
2. Nelson, L. R. Corporation.
3. Rain Bird Corporation.
4. Toro Company (The); Irrigation Division.
5. Weathermatic.

B. Description: UL listed, UV stabilized plastic housing rain sensor with the following properties:
1. Hardwire installation
2. 2-5 minute time duration to system shut down
3. Time to reset should be less than 4 hours
4. Operating temperature range 32 – 130 degrees
5. 24 volt, 3amp
6. Matched to controller station
7. Selectable rain shut off indexes at 1/8", ¼", ½". ¾" of rainfall

2.12 DRIP IRRIGATION SPECIALTIES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Agrifim.
2. Aquarius Brands, Inc.
3. Buckner; a division of Storm Manufacturing Group Inc.
4. Dig Corporation.
5. Geoflow, Inc.
6. Hendrickson Bros.
7. Hit Products Corporation.
8. Irritrol Systems.
9. Maxijet, Inc.
10. NDS/Raindrip.
11. Netafim USA.
12. Olson Irrigation Systems.
13. Orbit Irrigation Products, Inc.
14. Rain Bird Corporation.
15. Roberts Irrigation Products, Inc.
16. Salco Products.
17. Toro Company (The); Irrigation Division.

B. In-line [inside pipe] Emitter Systems:

1. Tubing: PE or PVC; 1/2-inch minimum ID, UV resistant.
2. Emitter: In-pipe device.

a. Body Material: UV Resistant PE or Vinyl
b. Design Flow: .5 to 1.0 gph.
c. Spacings 12” to 18” oc.
d. Pressure compensating from 15-50 psi
e. Minimum operation pressure if 15 psi
f. Minimum filtration 120 mesh
g. Self-flushing design
h. Includes an internal low pressure 2 psi check valve
i. Includes a non-chemical physical or copper root barrier

C. On-line [on pipe] Emitter Systems:

1. Tubing: Black PE tubing UV resistant.
2. Emitter: Attached to pipe drip device.

a. Body Material: UV Resistant PE or Vinyl
b. Design Flow: .5 to 2.0 gph.
c. Pressure compensating from 7-50 psi
d. Minimum operation pressure if 15 psi
e. Minimum filtration 120 mesh
f. Self-flushing design
g. Includes an internal low pressure 1.5 psi check valve

D. Pop Up Micro Spray:

1. Tubing: PE or PVC; 1/4-inch minimum ID, UV resistant.
2. 8” pop up microspray emitter:.

a. Body Material: UV Resistant PE or Vinyl
b. Design Flow: .5 to 1.0 gph.
c. Operating Pressure: 15-35PSI
d. 5’ wetting diameter, flat tragectory
e. Pressure compensating from 15-50 psi

E. Application Pressure Regulators: Brass or plastic housing, NPS 3/4, with corrosion-resistant internal parts; capable of controlling outlet pressure to approximately 20 psig.

F. Filter Units: Plastic housing with corrosion-resistant internal parts; of size and capacity required for devices downstream from unit.

1. Provide screening to 120 mesh size.
2. Minimum size 3/4”
3. Flow Range 1-12 gpm
4. maximum pressure 140 psi
5. Polyamide staking ring type filter

G. Air Relief Valves: Brass or plastic housing, with corrosion-resistant internal parts.

H. Vacuum Relief Valves: Brass or plastic housing, with corrosion-resistant internal parts.

2.13 CONTROLLERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Buckner; a division of Storm Manufacturing Group Inc.
2. Champion Irrigation Products.
3. Hit Products Corporation.
4. Hunter Industries Incorporated.
5. Irritrol Systems.
6. K-RAIN Manufacturing Corporation.
7. Nelson, L. R. Corporation.
8. Netafim USA.
9. Orbit Irrigation Products, Inc.
10. Rain Bird Corporation.
11. Superior Controls Co., Inc.
12. Toro Company (The); Irrigation Division.
13. Weathermatic.

B. Description:

1. General: Time clocks must provide the following features:
   a. Timing Device: Adjustable, 24-hour, 14-day clock, with automatic operations to skip operation any day in timer period, to operate every other day, or to operate two or more times daily
   b. A minimum of programming three fully independent programs with four start times per program.
   c. Manual or Semiautomatic Operation: Allows this mode without disturbing preset automatic operation
   d. Controller Stations for Automatic Control Valves: Each station is variable from approximately 5 to 120 minutes. Include switch for manual or automatic operation of each station
   e. Quantity of stations equal to the zones required plus 4 empty zones.
   f. Rain Sensor: Adjustable from one to seven days, to shut off water flow during rain
   g. Non-volatile memory for holding programs during power outages
   h. 120 volt input, 24 VAC output
   i. Control Transformer: 24-V secondary, with primary fuse
   j. Surge Protection: Metal-oxide-varistor type on each station and primary power
   k. With a cistern, pump start capability
   l. Hand held remote included with system
   m. Lockable cabinet with two matching keys.

2. Exterior Control Enclosures: NEMA 250, Type 4, weatherproof and provision for grounding.
   a. Body Material: Enameled-steel sheet metal or Stainless-steel sheet metal
   b. Mounting: Surface type for wall.

3. Wiring: UL 493, Type UF multiconductor, with solid-copper conductors; insulated cable; suitable for direct burial.
   a. Feeder-Circuit Cables: No. 12 AWG minimum, between building and controllers.
   b. Low-Voltage, Branch-Circuit Cables: No. 14 AWG minimum, between controllers and automatic control valves; color-coded different from feeder-circuit-cable jacket color; with jackets of different colors for multiple-cable installation in same trench.
   c. Splicing Materials: Manufacturer's packaged kit consisting of insulating, spring-type connector or crimped joint and epoxy resin moisture seal; suitable for direct burial.

2.14 BOXES FOR AUTOMATIC CONTROL VALVES

A. Plastic Boxes:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Armorcast Products Company.
    b. Carson Industries LLC.
    c. Nationwide Plastics, Inc.
    d. NewBasis.
    e. Oldcastle, Inc.
    f. Orbit Irrigation Products, Inc.
    g. USFilter/Plymouth Products, Inc.

2. Description: Box and cover, with open bottom and openings for piping; designed for installing flush with grade.

    a. Size: As required for valves and service.
    b. Shape: Round and rectangular
    c. Sidewall Material: Structural foam plastic.
    d. Cover Material: Structural foam plastic
    e. UV resistant
    f. Stainless steel screw lock
    g. Color: Black.

B. Drainage Backfill: #57 stone.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

B. Install detectable warning tape directly above Main Line piping only at 12” below finished grade.

C. Provide minimum cover over top of underground piping according to the following:

1. System Main Feed: Minimum depth of 30 inches below finished grade.
2. Main Line Piping: Minimum depth of 18 inches below finished grade
3. Circuit Piping: Minimum of 12 inches below finished grade
4. Sleeves: 24 inches or 12” below finished grade or pavement gravel sub-bases, whichever is deeper
    a. Extend sleeves 30” beyond edge of pavement.

3.2 PREPARATION

A. Carefully mark out the extent of lawn versus planting beds to avoid spray overlap. Spray irrigation of areas other than lawns is not allowed.

B. Confirm that the rough grades have been established prior to topsoil spreading.

C. Examine the site compared to the system design and notify the Architect of changes.
   1. Submit design changes to the Architect if revisions to the design are warranted

D. Verify existence of required sleeving.

E. Store pipe and fitting for project in an area that will not introduce dirt and debris into the interior.

3.3 PIPING INSTALLATION

A. Location and Arrangement: Drawings indicate location and arrangement of piping systems. Install piping as indicated unless deviations are approved on Coordination Drawings.

B. Install piping at minimum uniform slope of 0.5 percent down toward drain valves.

C. Install piping free of sags and bends.

D. Install groups of pipes parallel to each other, spaced to permit valve servicing.

E. Install fittings for changes in direction and branch connections.

F. Install unions adjacent to valves and to final connections to other components with NPS 2 or smaller pipe connection.

G. Install expansion loops in control-valve boxes for plastic piping.

H. Lay piping on solid subbase, uniformly sloped without humps or depressions.

I. Install PVC piping in dry weather when temperature is above 40 deg F. Allow joints to cure at least 24 hours at temperatures above 40 deg F before testing.

J. Install water regulators with shutoff valve and strainer on inlet and pressure gage on outlet. Install shutoff valve on outlet. Install below ground in control-valve boxes.

K. Water Hammer Arresters: Install between connection to building main and circuit valves aboveground or in control-valve boxes.

L. Install sleeves made of Schedule 80 PVC pipe and socket fittings, and solvent-cemented joints. Extend 30” beyond pavement or curb edges.

M. Install piping in sleeves under parking lots, roadways, and sidewalks. Avoid fittings within sleeves.

N. Install transition fittings for plastic-to-metal pipe connections according to the following:

   1. Underground Piping:

      a. NPS 1-1/2 and Smaller: Plastic-to-metal transition fittings.
      b. NPS 2 and Larger: AWWA transition couplings.

3.4 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. PE Piping Fastener Joints: Join with insert fittings and bands or fasteners according to piping manufacturer's written instructions.

E. PVC Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Pressure Piping: Join schedule number, ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
3. PVC Nonpressure Piping: Join according to ASTM D 2855.

3.5 VALVE INSTALLATION

A. Isolation valves: Install isolation valves with handles oriented to surface.

B. Pressure-Reducing Valves: Install in boxes for automatic control valves. Install full-size valved bypass.

C. Automatic Control Valves: install according to manufacturer’s recommendations with manual adjustment handles oriented to the surface.

D. Drain Valves: Install in underground piping in boxes for automatic control valves.

3.6 SPRINKLER INSTALLATION

A. Install sprinklers after hydrostatic test is completed.

B. Install sprinklers in final grades at manufacturer's recommended heights.

C. Locate part-circle sprinklers to maintain a minimum distance of 4 inches from walls and 2 inches from other boundaries such as curbs and walks unless otherwise indicated.

3.7 QUICK COUPLER INSTALLATION

A. Install quick coupler as per manufacturers' recommendations at a height below mower damage level.

B. Install approximately 6" by 6" by 6" concrete collar underground, covered by 1" of soil.

C. Paint exposed plastic parts black.

3.8 RAIN SENSOR INSTALLATION

A. Hardwire connection from time clock to sensor.

B. Place in an open area with no overhang as approved by the landscape architect or as shown on the plan.

C. Installation should be neat with organized wiring.

3.9 DRIP IRRIGATION SPECIALTY INSTALLATION

A. Install area connection tubes with 3" of cover and with galvanized stakes as needed.
   1. For each zone provide loop back to within 10' of the first emitter.

B. Install the number of drip emitter per plant according to TABLE 1 – DRIP SYSTEM PERFORMANCE REQUIREMENTS

C. For Trees, large shrubs, use drip line with internal emitters on "T" loops from main line.

D. For container shrubs choose drip line with internal emitters for regularly spaced shrubs and drip line with external emitter for irregularly spaced shrubs.

E. For mass plantings of small containers or plugs, use a grid of drip tube with internal emitters.

F. Install drip tubes as follows:
   1. Install on ground. Stake with galvanized stakes as needed to maintain contact.
   2. Drip tubing should be placed on the root ball, 3" from the edge and exposed.
   3. External emitters should be exposed to view.
   4. For container shrubs place beneath the mulch on the root ball.
   5. For grid layout, use a matching spacing to the planting.

G. Install application pressure regulators and filter units in piping near zone valves below ground in boxes. Orient the regulators to assist with maintenance.

3.10 AUTOMATIC IRRIGATION-CONTROL SYSTEM INSTALLATION

A. Equipment Mounting: Install interior controllers at eye level on wall.

   1. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.11 CONNECTIONS

A. Comply with requirements for piping specified in Division 22 Section "Facility Water Distribution Piping" for water supply from exterior water service piping, water meters, protective enclosures, and backflow preventers. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment, valves, and devices to allow service and maintenance.

C. Connect wiring between controllers and automatic control valves.

3.12 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

B. Equipment Nameplates and Signs: Brand each valve box where isolation valve, automatic control valves, pressure regulator valve, or filter is housed with a unique name that appears on the time clock and the as-built drawings.

1. Text: Minimum ½' letters branded into plastic valve box housing.
   a. Turf Valves – Use 1-50
   b. Drip Valves – Use 51-99
   c. Valves, Pressure Regulators & Other Equipment - Use 100 and above

C. Warning Tapes: Arrange for installation of continuous, underground, detectable warning tapes over underground piping during backfilling of trenches. See Division 31 Section "Earth Moving" for warning tapes.

3.13 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. System Main Feed & Main Line Leak Test: After installation, charge system and test for leaks with a pressure indicator over a 24-hour period. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, operate controllers and automatic control valves to confirm proper system operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Test spray heads for too little or too much pressure. Make adjustments in the system, including installing pressure compensation devices or boosting overall system pressure to provide a functioning system.

B. Any irrigation system or product will be considered defective if it:

1. Does not pass tests and inspections.
2. Does not provide manufacturer's recommended pressures throughout the system
3. Does not provide complete separation of grass and planting areas [individual trees may be over sprayed]
4. Does not provide matched precipitation rates throughout the lawn
5. Does not provide drip system delivery target rates for plant types.
6. Sprays water onto pavements, buildings, or signage.

7. Does not provide for easy maintenance as follows:
    a. Ball valves, filters, regulators are poorly oriented for hand access
    b. Automatic Valves are poorly oriented for access
    c. Irrigation equipment is installed at a grade that would encourage damage from mowers

C. Defective irrigation systems or components shall be repaired at no cost to the Owner.

3.14 FLUSH OUT CLEANING

A. Flush dirt and debris from piping before installing sprinklers and other devices.

B. Clean or replace all filters.

3.15 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that controllers are installed and connected according to the Contract Documents.
3. Verify that electrical wiring installation complies with manufacturer's submittal.

3.16 ADJUSTING

A. Provide at least three programmed time schedules.
    a. One is for immediate post planting where the system is run at high rates for a short duration.
    b. Second is for a longer-term establishment period, where distribution rates are reduced but still higher for plant establishment.
    c. Third is a long-term summer schedule distributing about 1” of precipitation to lawn areas per week and 70 gallons per week to shrubs.

B. Adjust automatic control valves to provide flow rate at rated operating pressure required for each sprinkler circuit.

C. Adjust sprinklers and devices so they will be flush with finish grade or as recommended by the manufacturer.

D. Adjust drip system to provide gallons per week delivery targets by adding and subtracting emitters.

3.17 DEMONSTRATION

A. Train Owner's maintenance personnel by providing the following instruction:
    1. Review the as-built materials with the owner
    2. Demonstrate how to program the clock.
    3. Demonstrate how to adjust heads
    4. Demonstrate how to clean filters and pressure regulation
    5. Review the site components of the system, identify valve boxes

END OF SECTION 328400

SECTION 329200 - TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Sodding.

B. Related Sections:

   1. Division 31 Section "Site Clearing" for topsoil stripping and stockpiling.
   2. Division 31 Section "Earth Moving" for excavation, filling and backfilling, and rough grading.
   3. Division 32 Section "Planting Irrigation" for turf irrigation.
   4. Division 32 Section "Plants" for border edgings.

1.3 DEFINITIONS

A. Final Acceptance: The proper installation of seed, sod, and meadow with final grades, mulch and irrigation functioning (if provided) with no indication of widespread plant death. For seeded and meadow areas, the seed must show germination with green shoots visible. It is possible to grant final acceptance to portions of the site without total project completion however all construction activities must be completed in the requested area.

B. Finish Grade: Elevation of finished surface of planting soil.

C. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

D. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

E. Planting Soil: The prepared earth [existing or imported as specified herein] used to backfill lawn or sod areas.

F. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

G. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

H. Turf: A groundcover established from either lawn type seeds, lawn type sod or meadow seeds.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.

1.5 INFORMATIONAL SUBMITTALS

A. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1. Certification of each seed mixture for turfgrass sod. Include identification of source and name and telephone number of supplier.

B. Qualification Data: For qualified landscape Installer.

C. Product Certificates: For soil amendments and fertilizers, from manufacturer.

D. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required initial maintenance periods.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf and meadow establishment.

1. Professional Membership: Installer shall be a member in good standing of the Professional Landcare Network, the NC Landscape Contractors Association, or the American Nursery and Landscape Association.
2. Experience: Three years' experience in turf installation in addition to requirements in Division 01 Section "Quality Requirements."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
4. Personnel Certifications: All personel who handle herbicides and herbicides shall be State licensed, for commercial.

B. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Soil Analysis: For each un-amended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of the soil.

1. Test soil components of Planting Soils Type A, B, C, D, E.
2. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
3. Test shall include mechanical analysis of sand, silt and clay components.
4. The soil-testing laboratory shall oversee soil sampling; with depth, location, and number of samples to be taken per instructions from Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
5. Soil tests shall include the following information:

    a. Percentage of sand, silt and clay.
    b. Cation exchange capacity.
    c. Percent of organic matter.
    d. Stated recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
    e. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.

C. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.

1.8 PROJECT CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Final Acceptance.

Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

Grass Type	Fall Season	Spring Season
Cool season grasses	September 15-December 15	February 1 to May 15
Warm season grasses	Sept 1 to Oct 15	May 15-July 15

B. Water Source:

1. The Owner shall provide water for:

   a. The construction period until Final Acceptance for the last phase of work.
   b. Final Acceptance for the last phase of work through the maintenance period.

2. The Contractor shall supply watering labor as follows:

   a. The construction period until Final Acceptance for the last phase of work.
   b. Final Acceptance for the last phase of work through the maintenance period.

1.9 MAINTENANCE

A. Initial Maintenance Service for Lawns [sod and seed areas]: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after lawns are installed and continue until plantings are acceptably healthy, well established, and deemed satisfactory per Part 3; but for not less than the Construction Maintenance Period below.

1. Construction Maintenance Period: 6 months. The Construction Maintenance Period will begin from the date of Final Acceptance for the last phase of work. Partial areas of turf deemed satisfactory per Part 3 require continued maintenance until all areas are deemed satisfactory per Part 3 and until final date of Construction Maintenance Period; whichever elapses last.

2. Landscape Maintenance Period - The Landscape Maintenance Period will begin from the date of the Construction Maintenance period [described above] lapses. Refer to Section 32-00-000 for Landscape Maintenance Specifications.

B. Continuing Maintenance Proposal: Any agreement of an Owner with the Contractor for annual landscape services would begin after the maintenance period elapses.

PART 2 - PRODUCTS

2.1 TURFGRASS SOD

A. Turfgrass Sod: Number 1 Quality/Premium, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.

B. Turfgrass Species: Zenith Zoysia.

C. Meadow Seed Carrier: Inert material, sharp clean sand or perlite, mixed with seed at a ratio of not less than two parts seed carrier to one part seed.

2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
   1. Provide lime in form of ground dolomitic limestone or calcitic limestone depending on soil test.

2.3 ORGANIC SOIL AMENDMENTS

A. Soil Conditioner: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1/2-inch sieve; soluble salt content of 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

   1. Organic Matter Content: 70 percent of dry weight.
   2. Sources: Agricultural, bark, biosolids; municipal compost; or source-separated or compostable mixed solid waste.
      a. Free of toxic materials to plant growth
      b. Free of weed seeds.

2.4 FERTILIZERS

A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
   1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
   1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.5 PLANTING SOILS

A. Planting Soil Type A: Existing, in-place surface soil. Verify suitability of existing surface soil to produce viable planting soil. Remove stones, roots, plants, sod, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth. Mix surface soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:

1. Depth of soil conditioner to mix in Planting Soil: 3/8”to 4”.
2. Weight of Slow-Release Fertilizer per 1000 Sq. Ft. consult soil test.
3. Weight of dolomitic limestone per soil test.

B. Planting Soil Type B: NOT USED.

C. Planting Soil Type C: Imported sandy loam topsoil formed under natural conditions blended with organic matter. Verify suitability of native surface topsoil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

1. Depth of soil conditioner to mix in Planting Soil: 3/8”to 4”.
2. Weight of Slow-Release Fertilizer as per soil test
3. Weight of dolomitic limestone as per soil test.

2.6 SEED STABILIZATION

A. Grass and meadow seed blankets and coverings:

1. Products for lawn areas: Free of plastic or other non-biodegradable materials, seed free, , available products that may be incorporated into the Work include, but are not limited to, the following:

   a. American Excelsior Company, Curlex NetFree
   http://www.americanexcelsior.com/erosioncontrol/products/netfree.php

   b. Granite Environmental, Coconut Blanket C4000BD
   (http://www.tdpltd.com/netlon-products/netpave-50.html)

   c. Tensar BioNet
   (http://www.nagreen.com/erosion-control-products/bionet-ecbs.php)

2. Products for storm water management areas: Made from biodegradable jute matting, free of plastic or other non-biodegradable materials, seed free.

2.7 MULCHES

A. General: The Contractor shall select the mulching products that best suit the grass seed selected. Choose from the following mulches:
1. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
2. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

B. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

2.8 PESTICIDES

A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting performance. Notify the Architect immediately and do not start landscape construction operations if:
   1. Grades or site features do not match the design.
   2. There is ponding or areas that do not appear to drain
   3. The subsoil contains no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
   4. If the soils are frozen or moist beyond that required to produce optimal working conditions.
   5. Excessively dry soil that is not workable and which is too dusty.
   6. If the subsoil is over compacted.
   7. If irrigation main and lateral lines have not been installed.
   8. If irrigation main or lateral line trenches have not been compacted.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Erosion Control Seeding Contamination – Evaluate the erosion control seeding used and confirm that potential seed sources will not interfere with the establishment of seeded lawns or meadows. Confer with the General Contractor on usage of erosion control seeding and potential threats to establishing lawns or meadows.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

   1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
   2. Protect grade stakes set by others until directed to remove them.

3. Protect areas that should not receive seed such as planting beds.

3.3 TURF AREA PREPARATION

A. Limit turf subgrade preparation to areas to be planted.

B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches.

1. General

a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
b. Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, trash, and other extraneous matter.
c. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.
d. Reduce elevation of planting soil to allow for soil thickness of sod.

2. Spread planting soil to a depth of 4 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
3. Thoroughly blend planting soil with organic amendments off-site before spreading
4. Apply lime and fertilizers on surface, and thoroughly blend planting soil.

C. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:

1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
2. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.
a. Note any areas on the plan that indicate tree root zones. These areas may require the use of hand tools.

D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.

E. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

F. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 SODDING

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade,

eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Lay sod across angle of slopes exceeding 1:3.
2. Anchor sod on slopes exceeding 1:6 or in the bottom of swales with steel staples spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.

C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.5 TURF RENOVATION

A. Renovate existing turf.

B. Renovate existing turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.

1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
2. Install new planting soil as required.

C. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.

D. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.

E. Mow, dethatch, core aerate, and rake existing turf.

F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 4 inches.
1. Confirm that there are no protected root zone areas that would require special procedures.

I. Apply soil amendments and initial fertilizers required for establishing new turf and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.

J. Apply seed or sod as shown on the plans and as required for new turf.

K. Water newly planted areas and keep moist until new turf is established.

3.6 TURF MAINTENANCE

A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant

bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Repair turf as necessary because of settling, erosion or settlement or other processes.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain irrigation systems, temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches .

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
1. Mow bermudagrass to a height of 1 inch.
2. Mow turf-type tall fescue to a height of 3 inches.

D. Turf Postfertilization: Apply fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.7 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 3 by 3 inches.
2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
3. Satisfactory Plugged Turf: At end of maintenance period, the required number of plugs has been established as well-rooted, viable patches of grass, and areas between plugs are free of weeds and other undesirable vegetation.
4. Satisfactory Sprigged Turf: At end of maintenance period, the required number of sprigs has been established as well-rooted, viable plants, and areas between sprigs are free of weeds and other undesirable vegetation.

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.8 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.9 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

C. Remove non-degradable erosion-control measures after grass establishment period.

END OF SECTION 329200

SECTION 329201 – SOIL EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.1 Contractor shall take every reasonable precaution throughout construction to prevent the erosion of soil and the sedimentation of streams, lakes, reservoirs, other water impoundments, ground surfaces, or other property as required by State and Local regulations.

1.2 The Contractor shall install all required silt fences, and construction entrances at the initiation of work, and have these measures reviewed and approved by the local permit authority prior to clearing and grading operations.

1.3 The Contractor shall, within 15 days of suspension or completion of land disturbing activities, provide permanent protective covering for disturbed areas. Temporary and permanent erosion control measures shall be coordinated to assure economical, effective, and continuous erosion and siltation control throughout the construction and post-construction period. Use the specified seed for both temporary and permanent seeding.

PART 2 - PRODUCTS

2.1 Asphalt for anchoring mulch shall be Type SS-1 Emulsion.

2.2 Fertilizer shall be 10-10-10 grade or equivalent.

2.3 Lime shall be dolomitic agricultural ground limestone containing not less than 10 percent magnesium oxide.

2.4 Mulch shall be small grain straw, hay, wood chips, asphalt emulsion, jute or other suitable material free of undesirable weed seed.

2.5 Phosphate shall be 20 percent superphosphate or equivalent.

2.6 Seed shall be 20% carpet grass, 24% Bermuda, 20% turf Fescue, 10% Creeping Red Fescue, and 24% Annual Rye grain. Bermuda seed shall be hulled for warm weather planting and unhulled for cool weather planting. Purity of seed shall be a minimum of 98 percent and germination shall be a minimum of 85 percent.

2.7 Silt fence shall consist of NCDOT Class A fabric supported by wood or metal posts spaced not more than 6 feet on center. The bottom of the fabric shall be buried a minimum of 6 inches.

2.8 Gravel for check dams shall be #57 washed stone.

2.9 Aggregate for construction entrance shall be #4 washed stone.

2.10 Stone rip rap for check dams and erosion control shall be NCDOT Class A or B as shown.

PART 3 - EXECUTION

3.1 General: Take every practicable measure during construction or suspension to work to minimize erosion and siltation. Measures should include good construction practices, temporary physical barriers to sediment travel, settling basins for new ditches, and establishment of vegetative cover.

3.2 Construction Practices

3.2.1 Avoid dumping soil or sediment into any wetland or watercourse.

3.2.2 Maintain an undisturbed vegetative buffer where possible between a natural watercourse and trenching and grading operations.

3.2.3 Avoid equipment crossings of streams, creeks, and ditches where practicable.

3.2.4 Grade all cut, fill and ditch slopes to minimum slope of 3:1, unless otherwise shown or directed.

3.3 Temporary Physical Barriers are required where sedimentation on off site property or excessive erosion is a problem.

3.3.1 Mulch shall be used for temporary stabilization of areas subject to excessive erosion and for protection of seedbeds after planting where required.

1. Apply grain straw and hay at a rate of 75 to 100 pounds per 1000 square feet and wood chips at a rate of 500 pounds per 1000 square feet. Jute and mesh should be installed as per manufacturer's instructions.

2. Asphalt emulsion for slope stabilization should be applied at a rate of 1,000 gallons per acre. Asphalt emulsion used for anchoring straw should be applied at a rate of 150 gallons per ton of straw.

3.3.2 Silt Fences shall be used at the base of slopes to restrict movement of sediment from the site. Clean silt fence of accumulated sediment after each rainfall event or when it exceeds a depth of 0.5 feet above natural grade.

3.3.3 Stone Check Dams, placed at the discharges of creeks, ditches, and swales, shall consist of Class A rip rap at minimum two feet high and three feet thick across the watercourse, with a one foot thick layer of gravel on upstream side. Remove sediment if accumulated to a depth of 1.0 feet at upstream face.

3.4 Vegetative Cover: Establish and maintain permanent vegetative cover on all unpaved areas disturbed by the work.

3.4.1 Preparation of Seedbed: Areas to be seeded shall be scarified to a depth of 4 inches and until a firm, well pulverized, uniform seedbed is prepared. Lime, phosphorous and fertilizer shall be applied during the scarification process in accordance with the following rates:

Lime: 45 pounds per 1000 square feet
Phosphorous: 20 pounds per 1000 square feet
Fertilizer: 17 pounds per 1000 square feet

3.4.2 Seeding: Disturbed areas shall be seeded with 2 to 3 pounds per 1000 square feet of the specified seed mixture. Seed shall be worked into the bed to a depth of 1/4 inch. Regrade and seed eroded areas immediately

3.4.3 Mulch all areas immediately after seeding. Mulch shall be applied and anchored as specified hereinbefore. Reapply as necessary to retain cover until grass is established.

3.5 Construction Entrance: Provide an aggregate drive, 20 feet wide by 50 feet long by 6 inches thick at each entrance to the site used by construction vehicles, until such time as the permanent roadway is constructed. Remove soil if accumulated to a depth greater than 0.5 inches.

3.6 Maintenance: The Owner and Contractor shall be responsible for maintaining all temporary and permanent erosion control measures. Temporary structures shall be maintained until such time as vegetation is firmly established in the area protected by the structure. Permanent streambank protection and grassed areas shall be maintained until completion of the project. Areas that fail to show a suitable stand of grass or which are damaged by erosion shall be immediately repaired.

END OF SECTION 329201

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SECTION 329300 - PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Plants.
2. Planting soils.
3. Landscape aluminum edgings.
4. Mulches – Organic and Inorganic.
5. Tree Stabilization
6. Tree Grates

B. Related Sections:

1. Division 01 Section "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
2. Division 32 Section "Site Furnishings" for exterior unit planters.
3. Division 31 Section "Site Clearing" for protection of existing trees and plantings, topsoil stripping and stockpiling, and site clearing.
4. Division 31 Section "Earth Moving" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
5. Division 32 Section "Turf and Grasses" for turf (lawn) and erosion-control materials.

1.3 DEFINITIONS

A. Final Acceptance: The proper installation of plant material with final grades, mulch and irrigation (if provided) functioning with no indication of widespread plant death. It is possible to grant final acceptance to portions of the site without total project completion however all construction activities must be completed in the requested area.

B. Backfill: The planting soil used to replace or the act of replacing earth in an excavation.

C. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

D. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

E. Finish Grade: Elevation of finished surface of planting soil.

F. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

G. Planting Area: Areas to be planted.

H. Planting Soil: The prepared earth [existing or imported as specified herein] used to backfill planting areas or to create planting beds.

I. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

J. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

K. Stem Girdling Roots: Roots that encircle the stems (trunks) or main roots of trees below the soil surface.

L. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

M. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

N. Environmental Conditions: Physical, chemical, and biotic factors affecting ecological community and ability for plants to survive.

O. Detrimental Conditions: Environmental conditions harmful to the health of proposed plants that can be corrected through supplemental site improvements. Harmful conditions include, but shall not be limited to the following: poor soil, poor drainage, or contaminated soil.

1.4 ACTION SUBMITTALS

A. Samples for Verification: For each of the following:
   1. Mulch: A 1-quart volume of each mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
   2. Mineral Mulch: 1 quart volume of each mineral mulch required, in sealed plastic bags labeled with source of mulch. Sample shall be typical of the lot of material to be delivered and installed on the site; provide an accurate indication of color, texture, and makeup of the material.
   3. Edging Materials and Accessories: Manufacturer's standard size, to verify color selected.
   4. Tree Grates, Frames, and Accessories: Manufacturer's standard cut sheets and model numbers

B. Soil Analysis: For each un-amended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt,

and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of the soil.

1. Test soil components of Planting Soils Type A, B, C, D, E, and F.
2. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
3. Test shall include mechanical analysis of sand, silt and clay components.
4. The soil-testing laboratory shall oversee soil sampling; with depth, location, and number of samples to be taken per instructions from Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
5. Soil tests shall include the following information:
    a. Percentage of sand, silt and clay.
    b. Cation exchange capacity.
    c. Percent of organic matter.
    d. Stated recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
    e. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.

B. Substitutions: The Contractor shall provide the products specified. Changes must be made by written submittal with reason and alternate suggestion.

C. Environmental Conditions: Prior to contract acceptance by Contractor, submit written description of environmental conditions preventing compliance with warranty.

1. As applicable, submit detrimental conditions and/or substitutions submittals.

D. Detrimental Conditions: Per encounter, submit written description of detrimental conditions with recommendation for correcting condition. Include cost estimate.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful establishment of plants.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Five years' experience in landscape installation in addition to requirements in Division 01 Section "Quality Requirements."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the following:

    a. Professional Landcare Network Certified Landscape Technician - Exterior, with installation specialty area(s), designated CLT-Exterior.
    b. Or Certified Ornamental Landscape Professional, designated COLP.
    c. Or actively certified by the North Carolina Landscape Contractors Association
    d. Four year degree in horticulture, landscape architecture or agronomy

5. Selection of plants purchased under allowances will be made by Architect, who will tag plants at their place of growth before they are prepared for transplanting.

B. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.
2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

C. Plant Pre-Approvals: Utilize the following methods for plant selection.

1. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to the Project that is larger than 5 gallon plants. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.

2. Plant Tagging: The Architect will not require nursery plant tagging.

D. Additional Plant Material Observation: Architect may observe plant material either at site before planting or once installed for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

E. Substitutions: Substitutions will be permitted only upon submission of proof that a specified plant is not obtainable and with written approval of proposed substitution by Landscape Architect.

1. Contractor shall propose the use of the nearest obtainable variety of the plant having the same essential characteristics that is equal to or greater in size to original specified plant.

F. Detrimental Conditions: The contractor shall notify the Owner and Landscape Architect in writing of all conditions considered detrimental to growth of plant material. State condition and submit proposal including costs for correcting condition.

G. Pre-installation Conference: Conduct conference at Project site.

1. The following individuals must be present:

a. GC Contractor's site representative responsible for the Landscape Contractor's work
b. The Landscape Contractor's branch manager [or Owner] and job estimator.
c. The Project supervisor who will be directly responsible for field work and/or paperwork.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

C. Do not prune trees and shrubs before delivery.

D. Protect bark, branches, and root systems from sunscald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

E. Handle planting stock by root ball or container.

F. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F until planting.

G. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

H. If plants are stored for over 24 hours provide the following:
1. Set balled stock upright on ground and cover ball with soil, peat moss, sawdust, or other acceptable material to prevent wind, cold, or heat damage to the roots.
2. Provide shade to shade requiring trees and shrubs.
3. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly-wet condition.

1.8 PROJECT CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services or utilities according to requirements indicated:

1. Notify Owner and Architect no fewer than two days in advance of proposed interruption of each service or utility.
2. Do not proceed with interruption of services or utilities without Architect's written permission.

C. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Final Acceptance.

1. Spring Planting: Mar 15 – May 15.
2. Fall Planting: Sept 15 – Dec 15.

D. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

E. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated or acceptable to Landscape Architect.

1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

F. Under no circumstances should work proceed prior to establishment of appropriate grades.

G. Water Source:

1. The Owner shall provide water for:

   a. The construction period until Final Acceptance for the last phase of work.
   b. Final Acceptance for the last phase of work through the maintenance period.

2. The Contractor shall supply watering labor as follows:

   a. The construction period until Final Acceptance for the last phase of work.
   b. Final Acceptance for the last phase of work through the maintenance period.

H. Unusual Field Conditions: It is the Contractor’s responsibility to communicate to the Architect unusual field conditions found at the project site before and during construction. The presence of unusual field conditions such as wind, wetness, soil issues, invasive weeds, will require the Contractor take note and advise the Architect on how best to remedy the discovery.

1.9 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner, or incidents that are beyond Contractor's control.
b. Structural failures including plantings falling, blowing over or settling out of plumb.
c. Faulty performance of tree stabilization, edgings, tree grates, or subdrainage.
d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Periods from Date of Final Acceptance :
a. Trees, Shrubs, Vines, Ornamental Grasses, Ground Covers, Biennials, Perennials, and Other Plants, metal edges, decorative mulches, landscape drainage features, landscape grading: 12 months.
b. Annuals: 3 months.

3. Include the following remedial actions as a minimum:

a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
c. There will be no limitation on replacements of each plant except for losses or replacements due to species intolerance of environmental conditions.

1) Contractor shall notify Landscape Architect in writing of any concerns related to species intolerance of environmental conditions prior to purchase of plant material; otherwise, purchased plant material will be accepted by Contractor as tolerant of environmental conditions. Detrimental conditions shall be corrected prior to installation of plant material and shall not be considered grounds for warranty exclusion.

d. Provide extended warranty for period equal to original warranty period, for replaced plant material. As required, continue extended warranty until leaf out to ensure health of replaced material. Plants shall be deemed dead if leaf out does not occur prior to end of spring.

4. All replacements shall be plants of the same kind as originally planted and shall be of size equal to that attained by adjacent plants of the same kind at the time replacement is made. They shall be furnished and planted as specified herein.

5. Removal and replacement shall be at no cost to the Owner.

1.10 MAINTENANCE SERVICE

A. Initial Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than Construction Maintenance Period below. Maintenance requirements at 12 month warranty review noted in Part 3 are exceptions when a shorter Construction Maintenance Period is specified below.

1. Construction Maintenance Period: 12 months. The Construction Maintenance Period will begin from the date of Final Acceptance for the last phase of work. Partial areas of the site substantially completed require continued maintenance until all areas of the site are deemed substantially complete and until final date of Construction Maintenance Period.

2. Landscape Maintenance Period - The Landscape Maintenance Period will begin from the date of the Construction Maintenance period [described above] lapses.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots will be rejected.
2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
3. Provide trees from active, consistently aged specimens.
4. Unless directly specified, provide only trees that are genetic clones of the requested variety.

B. Select Balled and Burlapped material from nurseries who utilize root pruning practices and have a systematic approach to hardening off newly dug material.

C. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

D. Provide small trees and shade trees that are grown on their own roots, not utilizing grafting or budding techniques (unless directed in the plant list).

E. Provide container plant material that is free from circling roots or pot bound conditions.

F. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

G. Labeling: Label at least one plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant as shown on Drawings.

H. If formal arrangements or consecutive order of plants is shown on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
1. Provide lime in form of ground dolomitic limestone.

2.3 ORGANIC SOIL AMENDMENTS

A. Soil Conditioner: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1/2-inch sieve; soluble salt content of 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Pine bark soil conditioner: finely ground, well composted, pine bark mulch with a maximum particle size of ¼".

2. Organic Matter Content: 70 percent of dry weight.
3. Sources: Agricultural, bark, biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
   a. Free of toxic materials to plant growth
   b. Free of weed seeds.

2.4 FERTILIZERS

A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

B. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory. Several different blends may be necessary to meet the requirements.

2.5 PLANTING SOILS

A. Planting Soil Type A: Existing, in-place surface soil. Verify suitability of existing surface soil to produce viable planting soil. Remove stones, roots, plants, sod, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth. Mix surface soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:

1. Screen to remove extraneous materials.
2. Ratio of soil conditioner to Surface Soil by Volume: 1:5.
3. Weight of Slow-Release Fertilizer per 1000 Sq. Ft. consult soil test.
4. Weight of dolomitic limestone per soil test.

B. Planting Soil Type B: NOT USED

C. Planting Soil Type C: Imported sandy loam topsoil formed under natural conditions blended with organic matter. Verify suitability of native surface topsoil to produce viable planting soil.

Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

1. Ratio of soil conditioner to Topsoil by Volume: 1:10.
2. Weight of Slow-Release Fertilizer as per soil test
3. Weight of dolomitic limestone as per soil test.

2.6 MULCH

A. Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1/2-inch sieve; soluble salt content of 2 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: Triple shredded hardwood.
2. Color: Natural.

2.7 DECORATIVE INORGANIC MULCHES

A. Hard, durable stone, washed free of loam, sand, clay, and other foreign substances, of following type, size range, and color:

TYPE	SIZE	COLOR	DESCRIPTION	LOCATION
TYPE I	1-2” & 3-4”	Blues, Grays and Tans	Rounded River Rock	Decorative Stone Areas within landscape; 50/50 blend on size ratios

2.8

2.8 METAL EDGING

A. Aluminum Edging: Standard aluminum edging, rolled edge, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.

1. Condition A: All locations where edging is utilized as a edge restraint for decorative stone installation within the landscape.
   a. Edging Size: 3/16 inch wide by 5 inches deep.
   b. Stakes: Tapered steel, a minimum of 15 inches long.
   c. Accessories: Standard tapered ends, corners, and splicers.
   d. Finish: Aluminum

2.9 TREE GRATES

A. Tree Grates and Frames: ASTM A 48/A 48M, Class 35 or better, gray-iron castings and ASTM A 36/A 36M steel-angle frames of shape, pattern, and size indicated; powdercoated aluminum.

B. Shape and Size: 60” square, two pieces

C. Thickness: 1.5”

D. Maximum Opening Dimension: ¼”, ADA Compliant.

E. Supply patina accelerator.

F. Openings with plugs for in-grade lighting

G. Trunk Diameter: Minimum 16” diameter, Expandable within system to 26” diameter.

H. Basis of Design:
1. Manufacturer: Ironsmith
2. Model: 6016 Olympian Tree Grate
3. Material: Aluminum
4. Finish: Powdercoat Gray; select from manufacturer full range.

2.10 SUB DRAINAGE

A. Drainage pipe: 4” black corrugated slotted PE pipe pre-wrapped in a geo-textile fabric capable of filtering clay soil from migrating into the pipe.

B. Drainage Gravel: Washed, sound crushed stone or gravel complying with ASTMD448.

2.11 STORM WATER MANAGEMENT PLANTING STABILIZATION

A. Seed blankets and coverings:

1. Products for storm water management areas: Made from biodegradable jute matting, free of plastic or other non-biodegradable materials, seed free.

2. Staples – galvanized staples 6” in length.

2.12 HERBICIDES

A. General: Pesticide registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.13 PESTICIDES

A. General: Pesticide registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as

required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

1. Use pesticides on an as-needed basis.

2.14 TREE STABILIZATION MATERIALS

A. Upright and Guy Stakes: Rough-sawn, sound, new hardwood Stakes and Guys:

1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated, pointed at one end.
2. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, galvanized-steel wire, two-strand, twisted, 0.106 inch in diameter.
3. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.
4. Flags: Standard surveyor's plastic flagging tape, white, 6 inches long.

B. Below Grade Root-Ball Stabilization Materials:

1. Upright Stakes and Horizontal Hold-Down: Rough-sawn, sound, new hardwood or softwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated; stakes pointed at one end.
2. Wood Screws: ASME B18.6.1.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.

1. Verify that subgrades are correct prior to spreading topsoil or spreading amendments.
2. Conduct water percolation tests to verify that planting depths and drainage will meet the needs of the plants that have been selected. Inform the Architect of any drainage issues.
3. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
4. Along roadways and in landscape islands, remove gravel and asphalt from landscape beds.
5. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
6. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
7. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out plants at locations directed by Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.
   1. For gridded layouts, provide surveyed offset stakes. Use field strings to aid in layout.
   2. For grade sensitive layouts, set up level lines and grade stakes to insure proper planting depths.

3.3 GENERAL REQUIREMENTS FOR ALL PLANTING TYPES

A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

B. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

D. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

E. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.

   1. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
   2. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
   3. Maintain required angles of repose of adjacent materials as shown on the Drawings. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
   4. Maintain supervision of excavations during working hours.
   5. Keep excavations covered or otherwise protected when unattended by Installer's personnel.
   6. If subdrainage is shown on Drawings or required under planting areas, insure contact between the root ball and subdrain pipe.

F. After excavation examine the area for potential drainage difficulties matched to plant varieties and inform the Architect of potential poorly drained areas. Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits. Discuss variations in the depth of planting with the Architect prior to planting.

G. Fill excavations with water and allow it to percolate away before positioning trees and shrubs.

H. Set out and space plants according to the planting plans and notes in even rows with triangular spacing unless otherwise indicated.

I. When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

J. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

K. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

L. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

M. Backfill plants with the materials and methods indicated in the Tables below and with the following instructions:

1. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
2. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
3. Continue backfilling process. Water again after placing and tamping final layer of soil.

3.4

3.4 MASS PLANTING AREA REQUIREMENTS

A. Preparation - Loosen subgrade of planting areas to a minimum depth indicated in the table below. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

Table 2

PLANT TYPE	TREATMENT AREA	SUBSOIL TREATMENT	EXCAVATION BACKFILL	PLANTING SOIL* DEPTH
Shrub and Ground-cover masses	entire planting area	Loosen 8” deep	Use Planting Soil*	6”
Mass perennials	entire planting area	Loosen 4” deep	Use Planting Soil*	6”
Mass annuals	entire planting area	Loosen 4” deep	Use Planting Soil*	8”
** Planting Soil Type C*				

1. Spread planting soil to a depth indicated in Table 2 but not less than required to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen,

muddy, or excessively wet. Mix planting soil with the subsoil to form an uneven soil horizon line.

2. Subsoil removed from excavations may not be used as planting soil.

3.5 STORM WATER MANAGEMENT PLANTING STABILIZATION

A. Planting plugs and small container plants in storm water management areas:

1. Prepare the soils according to plans and details including amendments.

2. Micro grade to meet the requirements of the grading plan.

3. Apply jute mat in continuous runs and attach with staples at 30” oc.

4. Cut a small slit in the jute matt and install plugs into soil.

5. If deer or water fowl pose a potential threat, use a single staple for each plant across the root ball to prevent the roots from being dislodged.

3.6 SOLITARY TREES AND SHRUBS PLANTING REQUIREMENTS

A. Preparation - Loosen area of planting areas to a minimum depth indicated in the table below. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

Table 3

	Treatment area	Soil treatment	Backfill from excavation
Solitary Trees	10’ wider than the root ball	Loosen 12” deep	Use Planting Soil TYPE A
Solitary Shrubs	10’ wider than the root ball	Loosen 12” deep	Use Planting Soil TYPE A

1. Soil generated from excavations may be used after properly amended as specified.

3.7 SOLITARY TREES AND SHRUBS PLANTING REQUIREMENTS

A. Preparation - Loosen area of planting areas to a minimum depth indicated in the table below. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

Table 4

	Treatment area	Subsoil treatment	Backfill from excavation	Planting Soil * depth in treatment area
Solitary Trees	10 wider than the root ball	Loosen 12” deep	Use Planting Soil*	8”

Solitary Shrubs	10 wider than the root ball	Loosen 12" deep	Use Planting Soil*	6"
* Planting Soil Type A and C; 50% blend of existing in place and imported soils				

B. Subsoil removed from excavations may only be used for 50% of planting soil.

3.8 PLANTING IN TREE PITS

A. Excavate tree pits according to the details, discard the excavated material.

B. Install drainage and gravel sumps as shown in the details

C. Contact the Architect for and inspection of results prior to proceeding.

D. Once approved, back fill the planter pits with Planter Soil as indicated on the drawings

E. Plant the plant material as indicated on the drawings. Install root stabilization.

F. Install material to appropriate depths, leaving room for the final application of mulch.
   1. Root crown shall be exposed after completion.

3.9 PLANT STABILIZATION

A. Install plant stabilization as follows unless otherwise indicated:

PLANT SIZE	STABILIZATION METHOD
6" in Caliper and Greater	Anchor 4 guys to wood deadmen buried at least 36 inches below grade. Provide turnbuckle and compression spring for each guy wire and tighten securely. Allow enough slack to avoid rigid restraint of tree. Provide soft flexible protection of the trunk from the guy wires. Attach flags to each guy wire, 30 inches above finish grade.
3" to 6" in Caliper	Anchor 3 guys to 30" wood stakes. Install guy wires allowing enough slack to avoid rigid restraint of tree. Provide soft flexible protection of the trunk from the guy wires. Attach flags to each guy wire, 30 inches above finish grade.
Less than 12' tall	Provide two 6' tall hardwood stakes driven into the ground at the edge of the root ball 2' deep. Fasten the tree to the stakes with flexible bands capable of holding the plant steady but not binding.

B. Root-Ball Stabilization: Install at- or below-grade stabilization system to secure each new planting by the root ball unless otherwise indicated.

1. Refer to planting plan for location of plants to be receiving underground stabilization. All trees within the main entry plaza area, drawing L-1.60 are to be installed via below ground staking measures.

2. Root-Ball Stabilization Device: Install root-ball stabilization system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.

3.10 PLANT PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Do not apply pruning paint to wounds.

3.11 TREE GRATE INSTALLTION

A. Install according to the details and manufacturer's instructions. Maintain a minimum of 1" gap between the bottom of the grate and the top of the mulch.

B. Provide a 3" gap between the inside diameter of the grate and the tree trunk.

C. Protect from damage during construction.

D. After construction, apply patina accelerator to cast iron grates.

3.12 EDGING INSTALLATION

A. Steel Edging: Install steel edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 30 inches apart, driven below top elevation of edging.

B. Chiseled Edging: Construct chiseled edge separating mulch areas from lawn as shown in the drawings.

3.13 PLANTING AREA MULCHING

A. Layout mulch beds carefully with smooth lines and as indicated on the drawings. Mulch backfilled surfaces of planting areas and other areas indicated.

B. Organic Mulch in Planting Areas: Apply over whole surface of mass planting areas or on isolated plantings as follows:

1. Initial Mulch Application to New Planting Areas:

    a. 2.5" minimum depth for trees, shrubs and groundcovers
    b. 1 ½" minimum depth for groundcovers, perennials, and annual beds.

2. Mulch Application to Existing Planting Areas:

    a. Supplement mulch as needed to restore entire mulch profile to depths noted for initial mulch application to New Planting Areas.

C. Do not place mulch within 3 inches of tree or large shrub trunks.

3.14 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable

plantings. Spray or treat as required to keep trees and shrubs free of weeds, insects and disease.

1. Supplement mulch when entire mulch profile is 50 percent of depth required for initial mulch application to New Planting Areas. Restore entire mulch profile to depth indicated in these specifications.

B. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

1. Supplement entire mulch profile to depth indicated in these specifications. Do not over-apply mulch which can negatively affect the health of plants.

C. Include the following required action at 12 months from Final Acceptance as part of warranty review:

1. Remove tree staking systems, above and below grade.
2. Remove tree saucers.
3. Expose root crowns of all trees planted on the job.

3.15 CLEANUP AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.

B. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

C. After installation and before Final Acceptance remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

3.16 DISPOSAL

A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

END OF SECTION 329300

SECTION 330505.31 – HYDROSTATIC TESTING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Hydrostatic testing of pressure piping.

B. Related Requirements:
   1. Section 33 31 23 - Sanitary Sewer Force Mains, Valves and Appurtenances: Pipe materials and accessories normally encountered with municipal sanitary sewage force mains.
   2. Section 33 14 13 - Water Distribution Piping: Pipe materials and accessories normally encountered with pressurized water distribution systems.

1.2 REFERENCE STANDARDS

A. American Water Works Association:
   1. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
   2. AWWA C605 - Underground Installation of PVC

1.3 ADMINISTRATIVE REQUIREMENTS

A. The foreman of the contracting crew must speak fluent English.

B. Any event requiring Engineer, Owners Representative, or Town of Kure Beach to be present will require a minimum of two (2) business day notice to schedule the event.

C. No valves are to be operated unless Engineer, Owners Representative, or Town of Kure Beach is present. Any valves operated without a Engineer, Owners Representative, or Town of Kure Beach present, or a directive may be subject to penalties.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittals.

B. Submit following items prior to start of testing upon request:
   1. Testing procedures.
   2. List of test equipment.
   3. Testing sequence schedule.
   4. Provisions for disposal of flushing and test water.
   5. Certification of test gage calibration.

C. Test and Evaluation Reports: Indicate results of piping tests.

D. Qualifications Statement:
   1. Submit qualifications for applicator upon request.

PART 2 PRODUCTS

2.1 HYDROSTATIC TESTING

A. Equipment:
   1. Pressure pump.
   2. Pressure hose.
   3. Water meter.
   4. Test connections.
   5. Pressure relief valve.
   6. Pressure Gage: Calibrated to 0.1 psi.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that piping and appurtenances are installed and ready for testing.

C. Verify that trenches are backfilled.

D. Verify that pressure piping thrust restraints have been installed. Where any section of piping is provided with concrete thrust blocking, the hydrostatic test shall not be made until at least 5 days after installation of the concrete thrust blocking unless otherwise approved.

3.2 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements.

B. Testing of Pressure Piping to be performed according to AWWA C600 (DIP), AWWA C605 (PVC) and the following as applicable:
   1. Hydrostatic testing procedure:
      a. Testing shall be performed in the presence of the Engineer, Owners Representative, or Town of Kure Beach. Testing shall be scheduled with Engineer, Owners Representative, or Town of Kure Beach a minimum of two business days in advance and shall not proceed until granted approval by Engineer, Owners Representative, or Town of Kure Beach. The contractor will pre-test the lines prior to Engineer, Owners Representative, or Town of Kure Beach arrival. The contractor is to cancel the test if the lines will not pass the required test, correct all visible leakage, and locate and repair leakage in lines which exceeds the specified amounts. When completed, the contractor will re-schedule the test.
      b. Slowly fill with clean potable water portion of piping to be tested, expelling air from piping. Fill and test mains and services.
      c. Close air vents after air is expelled.

d. Raise pressure to specified test pressure. For purposes of testing, working pressure shall be 100 psi and test pressure shall be 150 psi. The pressure gauge must be liquid filled with 2 psi increments maximum. The gauge must be a minimum of three feet above grade. No more than 3 psi can be lost during the two-hour test. The gauge must return to 0 psi when the test is completed. There will be no allowable leakage. Air testing will not be accepted on mains and services, but will be accepted for tapping sleeves, 40 psi for 15 minutes or hydrostatic testing @150 psi for 15 min with zero pressure loss for both.

e. Observe joints, fittings, and valves undergoing testing.

2. Hydrostatic Testing Requirements for Pipe Burst Installations

a. Subject pipe burst installations to a pressure test before connecting to direct bury mains. Testing shall be performed in the presence of Engineer, Owners Representative, or Town of Kure Beach. Testing shall be scheduled with Engineer, Owners Representative, or Town of Kure Beach a minimum of two business days in advance and shall not proceed until granted approval by Engineer, Owners Representative, or Town of Kure Beach.

b. The pipe shall be filled with clean potable water and pressurized to 1.5 times the working pressure at the point of testing with a minimum of 150 psi, for a period of no less than 24 hours and then subjected to the specified test pressure.

c. Pretest pipe burst installations for a period of 2 hours before notifying Engineer, Owners Representative, or Town of Kure Beach that the main is ready for a final pressure test. No final pressure test shall begin after 2:00 pm.

d. Perform testing as follows:

1) Test pressure shall be at least 1.5 times the working pressure at the point of testing with a minimum of 150 psi. Test pressure shall not be less than 1.25 times the working pressure at the highest point along the test section. Test pressure shall not exceed the pipe or thrust restraint design pressure. Test pressure shall not vary by more than +/- 5 psi for the duration of the test.

2) The pressure test duration shall be 2 hours.

3) Ensure that the pipe is full of water and that the air has been removed before testing.

e. Pressure testing is the responsibility of the Contractor, who shall provide materials, labor, and equipment.

3. If testing of piping and appurtenances indicates leakage greater than that allowed, locate source of leakage, make corrections, and retest until leakage is within acceptable limits.

4. Correct visible leaks regardless of quantity of leakage.

END OF SECTION 330505.31

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SECTION 33 05 07.13

UTILITY HORIZONTAL DIRECTIONAL DRILLING (HDD)

PART 1 GENERAL

1.1 SCOPE

A. Scope:
   1. Design, furnish and install the proposed piping alignment by horizontal directional drilling (HDD) construction methods, as shown on the drawings and in conformance with this specification. The work includes, but is not limited to, survey, design, excavation, dewatering, removal of all materials encountered in the horizontal directional drilling operations, disposal of all material not required in the work, testing, cleaning, restoration, and incidentals as shown on the drawings and as specified herein.
   2. The HDD method shall consist of directing a string of small pipe, known as a drill string, along a pre-determined profile to drill a pilot hole, enlarge the pilot hole, and pull the pipe into place. In general, the process uses a machine to rotate, advance and retract the drill string; a cutterhead for drilling the pilot hole; a back reamer to enlarge the pilot hole to the required diameter; a pulling head and bearing swivel to pull the pipe into place; a drill string head locating and guidance system; and drilling fluid to provide lubrication, remove the cuttings and spoil and maintain the integrity of the hole. The operations are to be completed while simultaneously providing ground stabilization techniques. The method shall include provisions for preventing uncontrolled inflow of loose or saturated soils.
   3. Contractor is responsible for completing any additional geotechnical/subsurface investigations required to identify and confirm the location of existing utilities along the proposed HDD alignment, and establish the appropriate parameters (i.e., limiting pressures, setback distances, depth of cover, etc.) for completing the design of the alignment, prior to the start of construction. Previously completed geotechnical/subsurface investigation reports are available as noted in the Contract Documents.
   4. Owner is responsible for obtaining the required general construction permits, easements and approvals, from the NCDOT, USACOE, State, and/or railroad agency. Permit documents are available as noted in the Contract Documents and Contractor shall follow the guidelines as stated within the permits.

B. General:
   1. Be responsible for the final design and constructed product, furnishing the design data, obtaining approval from agencies and for the safety of the operations and for personnel engaged in the work.
   2. Be responsible for furnishing the qualified labor and superintendence necessary for this method of construction.
   3. Furnish all items necessary to perform the HDD as shown on the drawings.
   4. Installation of all jointing and gasketing materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, and all other Work required to complete the HDD installations.

5. Any modifications, damages or detrimental consequences to the existing ground conditions, structures, facilities or utilities as a result of the Contractor's Work, shall be repaired and restored to its original condition as directed by the Engineer at no additional cost to the owner.

C. Coordination:
   1. Review installation procedures under other Sections and other contracts and coordinate with the Work that is related to this Section.
   2. Be responsible for coordinating construction activities with the respective authorities.

Cl. Related Sections:
   1. Section 32 92 01 – Seeding and Sodding.
   2. Section 31 23 34.01 – Excavation, Trenching, Dewatering, and Backfilling.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. NUCA, HDD Installation Guidelines.
   2. American Railway Engineering Association: Specifications, Part 5; Pipeline – Crossings Under Tracks or Located on Railroad Property – For Flammable and Nonflammable Substances.
   3. ASTM F1962: Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossings

1.3 SUBMITTALS

A. The Contractor must submit a Work Plan to the Engineer at least 20 days prior to start of HDD detailing the procedure and schedule to be used to execute the Project. The Work plan should include:
   1. Qualification evidence as noted in Article 1.5A Quality Assurance.
   2. HDD Operation Plan which shall include:
      a. Material and equipment list: Submittal shall include detail information on drill rig, pilot tube, slurry treatment plants, drill path monitoring system, pipes, fittings, and drilling fluids.
      b. Detailed information on tracking/steering tools and surface monitoring system, including detail plan and procedure on calculating and correcting drill path and azimuth.
      c. Drilling fluids: Submittal shall include mix designs, QA/QC procedures, and criteria for mud rejection based on anticipated ground behavior and HDD operation requirements. The Contractor shall verify ground conditions prior to planning and designing drill fluids with the information contained in the report.
      d. Construction schedule.
      e. Documentation showing proper calibration of all measuring or monitoring devices including, but not limited to, pressure gauges, flow meter, load cells, steering/tracking devices.

f. Site layout plan for rig side and pipe lay-down area, including list of equipment to be used.
g. Shop drawing for the breakaway swivel, including set up detail in accordance to pipe manufacturer's setting for recommended pullback force.

3. Boring Plan which shall include:
   a. Detail description and sequence of the work plan for the entire HOD operation, including entry and exit point site preparation and restoration.
   b. The anticipated number of reams and detail information of each reamer to be used.
   c. Detail on drill rig, pilot hole, and steering/tracking system to be used, including rig pulling capacity and torque.
   d. Drilling rod length in feet.
   e. The anticipated drill rate for pilot tube boring, reaming, and pipe pull back, including correction plan for buoyancy.
   f. Drilling fluid pumping capacity.
   g. Details of pipe fusion methodology.
   h. Drill mud mixing and treatment procedure.
   i. Borehole cuttings handling and disposal procedure.
   j. Plans for protection of existing utilities or facilities.
   k. Pipe assembly procedure on pipe lay-down area, including pipe support method and design to optimize pipe pull-back operation and prevent excessive sagging of pipes.
   l. Calculation showing the maximum anticipated pullback load and stress on pipe during pull-back. The calculation shall be prepared and certified by a registered Professional Engineer in the State of North Carolina.
   m. Calculation of anticipated maximum and optimum drill mud pressure during the entire HDD operation. The calculation shall be prepared and certified by a registered Professional Engineer in the State of North Carolina.
   n. Contingency plan for mud frac-out, excessive settlement or heaving, major equipment failure, any other unanticipated advertent situations, and situations from unexpected ground conditions e.g. boulders or artesian condition.
   o. Daily report providing the details of monitoring to include, but not limited to the following:
      1) Pilot hole data showing pilot hole and its deviation from the original path.
      2) Steering data showing progress made every day.
      3) A summary report or graphic showing desired and true alignments.
   p. Daily progress report, including advance rate, quantity of material used, observed pull-back load, and drilling fluid pressure.
   q. Plan for containment of residuals and water for installation of sewer force mains.
   r. Procedures including, but not limited to, monitoring for gases encountered shall be submitted.
   s. Hazardous chemical list as well as all MSDS and technical data sheets.

B. Contractor must demonstrate expertise in "trenchless" methods by providing a list of five (5) utility references for which similar work has been performed in the last two years. The references should include a name and telephone number where contact can be made to verify the Contractor's capability. The Contractor must provide documentation showing successful completion of the projects used for reference. Conventional trenching experience will NOT be considered applicable.

C. Have completed HDD pipe installations of same size diameter or larger and have successfully completed lengths as shown on drawings or longer, crossings of railroads, major state roads, or bodies of water. Provide documentation in qualification submittal.

D. Contractor is required to bring to the attention of the Engineer any known discrepancies with actual HDD methods that the Contractor will be performing. This shall be stated, in writing, to Engineer no later than the pre-construction meeting.

E. Submit daily reports to the Engineer, following completion of the pilot bore hole, separately for each HDD operation. At minimum, the report shall include the following:
   1. Project information
   2. Name of data collector
   3. Site photos during operation
   4. Steering and tracking data log
   5. Deviations between the desired and the true alignments

F. Submit a separate Bore Path Report to the Engineer within seven days upon completion of each HDD operation. At a minimum, the report shall include the operation. At minimum, the report shall include the following:
   1. Project information
   2. Name of data collector
   3. Site photos during operation
   4. Date wise steering and tracking data log, including summary of desired and true alignments. Include horizontal and vertical alignments. Collected data points shall be provided in MS Excel format.
   5. Record drawings of the installed pipeline, including plan and profile of theoretical alignment
   6. Observed pullback force (pound-force) vs. pipeline in borehole (feet), data recorded at 5-ft intervals.

1.4 DESCRIPTIONS AND INCIDENT REPORTS FOR DISRUPTION OR UNEXPECTED STOPPAGE, IF ANY.

A. QUALITY ASSURANCE
   1. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   2. American Railway Engineering Association: Specifications, Part 5; Pipeline – Crossings Under Tracks or Located on Railroad Property – For Flammable and Nonflammable Substances.
   3. ASTM F1962.
   4. NUCA, HDD Installation Guidelines.

B. All pipes and fittings shall be designed and provided by a single manufacturer to maximize reliability and compatibility. The drilling supervisor must be adequately trained to operate the specific equipment to be used on the project and will have at least ten years of experience in HDD operations. The supervisor shall remain on the project site during the entirety of the HDD program. Contractor shall submit the names and resumes of all supervisory field personnel to the Engineer for review and approval prior to the start of construction.

C. Pipe fusion shall be performed by qualified and trained personnel or agency that is certified by the pipe manufacturer. Qualifications of the HDD pipe fuser shall be submitted and subject to review and approval by the Engineer.

D. The qualifications of the drilling fluid specialist and drill path tracking specialist shall be submitted to the Engineer for review and approval. Work being performed within the North Carolina Department of Transportation's (NCDOT) right-of-way shall be done in accordance with the latest NCDOT Standard Specifications and Drawings.

E. Work being performed at river crossings shall be done in accordance with USACE/NCDEQ regulations.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work.

B. Handle all pipe, fittings, specials and accessories carefully with approved handling devices. Handling devices shall include ropes, fabric, or rubber-protected slings and straps. Chains, cables, or hooks inserted into the pipe ends shall not be used. Two slings spread apart shall be used for lifting each length of pipe. Do not drop or roll material off trucks.

C. Store pipes and fittings on heavy wood blocking or platforms so they are not in contact with the ground. Pipe supports shall be spaced suitably and of such widths as not to allow deformation of the pipe at the point of contact with the supports.

D. Stacking of pipe shall be limited to a height that will not cause deformation of the bottom pipes under anticipated temperature conditions.

E. All ends of stored piping shall be securely capped/plugged to prevent entry of debris.

PART 2 PRODUCTS

2.1 MATERIALS

PVC Pipe Fusible C-900 DR 18, 235psi - Potable Water (4" thru 12").

MATERIAL / SPECIFICATION:

Fusible AWWA C-900 Polyvinyl Chloride, PVC, Pipe shall meet or exceed the performance specifications of:

A. ASTM D1784, manufactured from compounds with cell classification 12454.
B. Manufacture shall be listed with the Plastic Pipe Institute 9PPI) as meeting the recipe and mixing requirements for pipe in this classification.
C. Extruded with a unique formulation, for fusible pipe, that meets all requirements of PPI TR-2 "PPI PVC Range Composition Listing of Qualified Ingredients".
D. Shall comply with and be labeled as approved by the National Sanitation Foundation (NSF) for use in potable water lines meeting NSF 61 or NSF-pw.
E. Pipe shall be clean and ends shall be tarped during shipment.
F. Pipe shall be extruded with plain ends. The end shall be square to the pipe and free of any bevel or chamfer.
G. Fusible pipe shall be joined per the manufacture's recommendation.
H. Installation shall not exceed manufacture's bending radius and safe pulling force.
I. No solvent-cement weld pipe or fittings will be accepted.
J. Affidavit of compliance to this specification shall be available upon request.

2.2 EQUIPMENT

A. General
   1. The directional drilling equipment, as a minimum, shall consist of a directional drilling rig of sufficient capacity to perform the bore(s) and pull-back of the pipe(s), a drilling fluid mixing & delivery system of sufficient capacity to successfully complete the crossing, a guidance system to accurately guide boring operations, and trained and competent personnel to operate the system. All equipment shall be in good, safe operating condition with sufficient supplies, materials and spare parts on hand to maintain the system in good working order for the duration of this project. All required equipment shall be included in the contingency plan as submitted per these specifications. Incidental materials that may or may not be used to install the product depending on field requirements are not paid for separately and will be included in the cost of the installed product.

B. Drilling Rig
   1. The directional drilling machine shall consist of a hydraulically powered system to rotate, push and pull drill pipe while delivering a pressurized fluid mixture to a drill head. The machine shall be anchored to withstand the pulling, pushing and rotating forces required to complete the project.
   2. The drilling rig hydraulic system shall be of sufficient pressure and volume to power drilling operations. The hydraulic system shall be free from leaks.
   3. The drilling rig shall have a system to monitor pull-back hydraulic pressure during pull-back operations.

C. Drill Head
   1. The horizontal directional drilling equipment shall produce a stable fluid lined tunnel with the use of a steerable drill head and any subsequent pre-reaming heads.
   2. The system must be able to control the depth and direction of the drilling operation.
   3. Drill head shall contain all necessary cutters and fluid jets for the operation and shall be of the appropriate design for the ground medium being drilled.

D. Drilling Fluid System
   1. Drilling Fluid (Drilling Mud)
      a. Drilling fluid shall be composed of clean water and the appropriate additive(s) for the fluid to be used. Water shall be from a clean source and shall meet the mixing requirements of the mixture manufacturer(s). The water and additives shall be mixed thoroughly to assure the absence of any clumps or clods. No hazardous additives may be used.
      b. Drilling fluid shall be maintained at a viscosity sufficient to suspend cuttings and maintain the integrity of bore wall(s), while minimizing the likelihood of ground fracture causing frac-out. The Contractor shall be able to modify the mix design for anticipated ground conditions. Only environmentally compatible or bio-degradable mix designs are to be used. No additional chemicals or polymer surfactants shall be allowed to be added to the drilling fluid unless they have been submitted per this specification.
      c. The density, viscosity, pH value, circulation, volume, and solid content of the fluid are to be tested and considered to assure compatibility between the drilling fluid mixture and native soil after proper identification and characterization.

d. Drilling fluid shall be disposed of off-site in accordance with local, state and federal requirements and/or permit conditions.

2. Mixing System
   a. A drilling fluid mixing system shall be of sufficient size to mix and deliver drilling fluid for the project.
   b. The mixing system shall be able to ensure thorough mixing of the drilling fluid. The drilling fluid reservoir tank shall be sized for adequate storage of the fluid.
   c. The mixing system shall continually agitate the drilling fluid during drilling operations.
3. Drilling Fluid Delivery and Recovery System
   a. The drilling fluid pumping system shall have a minimum capacity to supply drilling fluid in accordance with the drilling equipment pull-back rating at a constant required pressure.
   b. The delivery system shall have filters or other appropriate in-line equipment to prevent solids from being pumped into the drill pipe.
   c. Used drilling fluid and drilling fluid spilled during drilling operations shall be contained and properly disposed of. The use of spill containment measures shall be maintained around drill rigs, drilling fluid mixing system, entry and exit pits and drilling fluid recycling system (if used) to prevent spills into the surrounding environment. Pumps, vacuum truck(s), and/or storage of sufficient size shall be in place to contain excess drilling fluid.
   d. A closed-loop drilling fluid system and a drilling fluid cleaning system should be used to whatever extent practical, depending upon project size and conditions. Under no circumstances shall drilling fluid that has escaped containment be reused in the drilling system.

E. Drilling Control System
1. Calibration of the electronic detection and control system shall be verified prior to the start of the bore.
2. The drilling head shall be remotely steerable by means of an electronic or magnetic detection system and be able to control depth and direction of the pipe accurate to a window of ±2 inches. The steering and tracking system must provide the following information, and shall be calibrated before use:
   a. Roll and pitch angles
   b. Depth and length
   c. Transmitter temperature
   d. Battery status
   e. Coordinates
   f. Azimuth
   g. Correction for azimuth
3. Point of rotation of the head shall also be monitored.
4. Horizontal and vertical alignment shall be plotted at 10-ft intervals.
5. Borehole alignment tolerance:
   a. Vertical:
      1) 2.0 feet in 100 linear feet.
      2) No reverse curvature.
      3) Total deviation not to exceed 5.0 feet.
   b. Horizontal:
   c. 2.0 feet in 200 linear feet.
   d. No reverse curvature.

e. Total deviation not to exceed 7.0 feet.

F. Pipe Pull Heads
1. Pipe pull heads shall be utilized that employ a positive through-bolt design assuring a smooth wall against the pipe cross-section at all times.
2. Pipe pull heads shall be specifically designed for use with the various types of pipe and shall be as recommended by the pipe supplier.
3. Pipe pull heads shall be equipped with a data logger to record pipe pullback force vs. pipe length during all pipe installations.

G. Pipe Rollers
1. Pipe rollers, if required, shall be of sufficient size to fully support the weight of the pipe during handling and pullback operations.
2. A sufficient quantity of rollers and spacing, per the pipe supplier's guidelines shall be used to assure adequate support and excessive sagging of the product pipe.

H. Tracer Wire
1. Two tracer wires shall be installed and taped to the drill host pipe at 10' intervals.

PART 3 EXECUTION

3.1 INSTALLATION

A. The Contractor shall notify the Engineer at least three (3) working days prior to start of construction. Drilling or installation work shall not begin until the Engineer or Engineer's Representative is present at the job site and agrees that prior preparations for the operation have been made.

B. Contractor shall:
1. Be responsible for carrying out all HDD work in strict conformance to the requirements specified in the contract drawings, specifications, and permits from all applicable agencies. This includes being in compliance with the lawful requirements and permits of the NCDOT, Cape Fear Public Utility Authority, public agencies, and owners of public utilities or other facilities respecting the safeguarding of structures, air, ground, water, and other improvements that might be endangered by the HDD.
2. All personnel shall be fully trained in safety according to OSHA 1926 and equipped in their respective responsibilities.
3. Perform the HDD simultaneously and continuously until the pipe is in final position.
4. Be responsible for means and methods of HDD, and shall ensure the safety of the Work, the Contractor's employees, the public, and adjacent property, whether public or private.
5. Maintain traffic flow at all times during the progress of the Work. Provide adequate signs, barricades, flag persons, lights and other control devices in accordance with the provisions and requirements of the NCDOT standards. No lanes of traffic shall be closed without prior approval.
6. Provide erosion and sediment control to minimize erosion and the transport of sediment beyond the limits of the work area.

7. Anticipate that portions of the HDD will be below the groundwater table and dewatering will be required.
8. Verify site conditions and access prior to any preparation or mobilization work to ensure on-time and prior delivery of pipes, material and equipment. Work performed for such purposes shall be incidental to the Work.
9. Request instructions from Engineer in writing, before proceeding, if there is a conflict between manufacturer's recommendations and the Drawings or Specifications.
10. Be responsible for all testing, survey, and documentation of the pre/post construction site conditions, to provide as a basis of comparison for the post construction conditions to be evaluated.
11. Carry out excavation for entry, exist, recovery pits, slurry sump pits, or any other excavation as specified in the Contract documents. Drill mud shall be contained in the sump pit and hauled offsite.
12. Provide all necessary adapters, specials and connection pieces required when connecting different types and sizes of pipe or connecting pipe made by different manufacturers.

C. HDD Operations:
   1. Pilot Hole Bore:
      a. Pilot hole shall be drilled along bore path. In the event that the pilot bore does deviate from the bore path, it may require Contractor to pull-back and re-drill from the location along bore path before the deviation.
         1) For mains, pilot hole shall have a tolerance of +2 feet horizontal and vertical along bore path, but in no case, shall depth of bury be less than the minimum specified.
         2) Determine and document cutterhead location every 25 feet.
      b. The Contractor shall limit curvature in any direction to reduce force on the pipe during pull-back. The minimum radius of curvature shall be no less than that specified by the pipe supplier and as indicated on the drawings.
   2. Reaming:
      a. After successfully completing the pilot hole, the bore hole shall be reamed to a diameter which meets the requirements of the pipe being installed.
      b. Perform pre-reaming operations as necessary for proper pipe installation.
      c. In the event of a drilling fluid fracture, returns loss or other loss of drilling fluid, the Contractor shall be responsible for restoring any damaged property to original condition and cleaning up the area in the vicinity of the damage or loss.
   3. Pipe Pull-Back and Insertion:
      a. Pipe shall be fused prior to insertion, if the site and conditions allow, into one continuous length.
      b. Contractor shall handle the pipe in a manner that will not over-stress the pipe prior to insertion. Vertical and horizontal curves shall be limited so that the pipe does not bend past the pipe supplier's minimum allowable bend radius, buckle, or otherwise become damaged. Damaged portions of the pipe shall be removed and replaced.
      c. The pipe entry area shall be graded as needed to provide support for the pipe and to allow free movement into the bore hole.
         1) The pipe shall be guided into the bore hole to avoid deformation of, or damage to, the pipe.

2) The pipe may be continuously or partially supported on rollers or other Owner and Engineer approved friction decreasing implement during joining and insertion, as long as the pipe is not over-stressed or critically abraded prior to, or during installation.
3) A swivel shall be used between the reaming head and the pipe to minimize torsional stress on the pipe assembly.

d. Contractor to monitor and control the pressure/force applied to ensure that pipe manufacturer's recommended limits are not exceeded.
e. Once pull-back operations have commenced, the operation shall continue without interruption until the pipe is completely pulled through the bore hole.
f. Removal of soil cuttings and pull back shall be closely monitored to minimize frac-out and ground surface movement. Any damages caused by the Contractor's operations shall be corrected by the Contractor.

4. Slurry Removal and Disposal:
   a. Handling and disposal of soil cuttings shall be in accordance with regulations of the state and local government agencies, permit requirements, and Contractor's approved plan.
   b. Contain excess drilling fluids at entry and exit points until recycled or removed from site. Provide recovery system to remove drilling spoils from access pits.
      1) Remove, transport and legally dispose of drilling spoils off site.
         a) Do not discharge drilling spoils in sanitary sewers, storm sewers, or other drainage systems.
         b) When drilling in suspected contaminated soil, test drilling fluid for contamination before disposal.
      2) When drilling fluid leaks to surface, immediately contain leak and barricade area from vehicular and pedestrian travel before resuming drilling operations.
      3) Complete cleanup of drilling fluid at end of each work day.

3.2 FIELD QUALITY CONTROL

A. Furnish, operate and maintain instrumentation that will accurately locate the pilot hole, measure drilling fluid flow discharge rate and pressure, and measure stresses on pipe during installation.

B. Engineer shall have access to instruments, gages, and readings at all times.

C. Maintain drilling logs including dates, times and locations, soil condition, drilling data such as depth, angle and rate of penetration, and utility crossings.

D. Monitor and record use of drilling fluid.

E. Monitor and record stresses imposed on pipe during pulling.

3.3 TESTING OF PIPING

A. General:
   1. Refer to Section 33 05 05.31 – Hydrostatic Testing of Water Distribution and Sanitary Sewer Force Mains, for hydrostatic/pressure testing specifications.

Prior to pullback, perform an allowable leakage test on the full length of pipe after all sections have been welded or fused.

3.4 CLEANING AND DISINFECTION

A. General:
   1. Refer to Section 33 14 20 – Disinfection of Water Distribution Mains, for pipe cleaning, flushing, and disinfecting specifications.

3.5 SITE RESTORATION

A. Any damage or detrimental consequences resulting from ground heaving, subsidence, frac-out, structural or support failure, or excessive loss of water in relation to HDD or other works by the Contractor shall be repaired at no additional cost to the Owner.

B. Plan for restoration and repair shall be in accordance with the approved submittal. Remediation plan and documentation of the repair and restoration works process shall be completed and submitted for record to the Engineer.

C. Following drilling operations, Contractor will demobilize equipment and restore the work-site to its pre-construction condition. Any noticeable surface defects due to the drilling operation shall be repaired by Contractor.

3.6 WORK REJECTION

A. The following comprise conditions under which work shall be rejected:
   1. When there is any indication that the installed product has sustained damage, stop all work and notify the Engineer immediately. As part of the investigative measure to determine extent of the damage, the pressure and I or mandrel test shall be carried out as directed by the Engineer at no additional cost to the Owner. Perform all testing within 24 hours unless otherwise directed by the Engineer. Furnish a copy of all test results and bore logs to the Engineer for review and determination of conformance of installed product to specifications and performance requirements.
   2. If an obstruction is encountered during boring, reaming or pullback, which prevents forward progress of the installation.
   3. If the pipe shall fail hydraulic pressure test according to Section 33 05 05.31 – Hydrostatic Testing of Water Distribution and Sanitary Force Mains.
   4. Any other defect in material or workmanship which would affect the performance or design life of the installed pipeline.

3.7 RECORD KEEPING

A. Contractor shall maintain a daily project log of drilling operations and a guidance system log with a copy given to Engineer at completion of boring. Record drawings shall be certified as to accuracy by Contractor as required in Section 01 78 39 – Project Design Drawings Requirements.

END OF SECTION

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SECTION 330509.33 – THRUST RESTRAINT FOR UTILITY PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe joint restraint systems for all pressurized mains (water and wastewater force).
   2. Includes fittings, valves, dead-ends, and other locations where change in pipe direction requires joint restraint.

B. Related Requirements:
   1. Section 33 05 05.31 – Hydrostatic Testing: Materials and methods for pipeline cleaning and testing.
   2. Section 33 05 07.13 - Horizontal Directional Drilling: Materials and methods for piping and appurtenances.
   3. Section 33 05 07.23 - Jacking and Boring: Materials and methods for carrier pipes and appurtenances.
   4. Section 33 14 13 - Water Distribution Piping and Appurtenances: Materials and methods for piping and appurtenances.
   5. Section 33 31 23 - Sanitary Sewer Force Mains, Valves and Appurtenances: Materials and methods for piping, valves, and appurtenances.

1.2 REFERENCE STANDARDS

A. American Water Works Association:
   1. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.

B. ASTM International:
   1. ASTM A536 – Standard Specification for Ductile Iron Castings.

1.3 COORDINATION

A. General – Coordinate Work of this Section with the installation and modification of pressure main valves, bends, reducers, and dead-end fittings and pipe joints that re- quire restraint.

B. Joint Restraint Systems – Field or factory applied joint restraint systems shall be used unless otherwise indicated by the ENGINEER. When multiple valves, bends, fittings are in close proximity, ENGINEER to design adequate total restraint length required for fitting combination(s). The combined fitting restrained length total must equal the sum of the individual fitting restrained lengths. Individual restrained end lengths ap- plied to combined fitting end lengths can result in failure during testing or operation.

C. Thrust Blocks – Concrete thrust blocking shall only be used when required for special installations, such as such as cut-in tees, tapping sleeves, plugged/capped sections

removed from service, or other situations that would require retrofitting an existing service pipeline with joint restraints. ENGINEER shall design adequate size and weight of blocking to be installed for special installations.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer catalog information for restrained joint details and installation instructions.

B. Shop Drawings:
   1. Indicate restrained joint details and materials being used.
   2. Submit schedules showing restraint device models and locations to be installed.
   3. Include restrained joint installation procedures.

C. Manufacturer's Certificate: Certify that products meet or exceed specified require- ments.

D. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record locations of joint restraints on design plan and profile drawings by begin and end station as proceeds daily and transfer field data to final record drawing submittal.

1.6 QUALITY ASSURANCE

A. Perform Work according to AWWA 600 standards and manufacturer instructions.

B. Perform pressure testing according to Section 33 05 05.31 – Hydrostatic Testing.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

C. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.

PART 2 PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Provide pressure pipelines (water and force mains) with restrained joints and/or blocking at any change in direction including hydrant assemblies, bends, tees, reduc-

ers, blow-offs, dead-end mains, cut-in tees, tapping sleeves, etc. Thrust restraint shall be designed for a minimum pressure of **150 psi** at the lowest elevation in the pipeline test section.

2.2 JOINT RESTRAINT SYSTEMS

A. Refer to CFPUA Material Specification Manual (MSM) for the following products:

MSM Section	Material
C	Joint Restraints

B. Unless otherwise indicated, joint restraint systems may be factory or field applied sys- tems.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify location of piping restraint locations in advance of pipe laying operations.

B. Verify that pipe and fittings identified for restraint are ready to receive Work and the correct restraint device is applied to that location.

C. Field measure and verify pipe restraint lengths indicated on drawings for Work to be installed.

3.2 PREPARATION

A. Clean surfaces of pipe and fittings that are to receive joint restraint systems.

3.3 INSTALLATION

A. Install joint restraint system such that joints are mechanically locked together to pre- vent joint separation in accordance with the manufacturer recommendations.

B. In special installations where concrete thrust blocking is required, allow 7-day mini- mum cure time before placing pipe pressure load on concrete blocking.

END OF SECTION 330509.33

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SECTION 331413 – WATER DISTRIBUTION PIPING, VALVES, HYDRANTS, AND APPURTENANCES

PART 1 GENERAL

1.01 DESCRIPTION:

A. This section gives the requirements for installation of water lines, including pipe, valves, and service connections and sampling stations. Excavation, trenching, and backfilling is covered in SECTION 02220: Excavation, Grading, Trenching and Backfilling.

B. The foreman of the contracting crew must speak fluent English.

1.02 SUBMITTALS

A. Test Reports: Submit the results of the bacteriological tests to the Engineer, Owners Representative, and Town of Kure Beach Engineering Inspector.

B. Shop Drawings: Contractor shall furnish to Engineer, Owners Representative, and Town of Kure Beach shop drawings and material specification sheets of all material and items to be installed or delivered as specified in Section 01340: Submittals.

PART 2 PRODUCTS

2.01 PIPE

2.01.1 GENERAL: Water main and service shall be constructed of PVC pipe except when ductile iron is required. Water service laterals shall be constructed of CTS PE tubing.

2.01.2 DUCTILE IRON PIPE shall conform to ANSI/AWWA C150/A21.50, ANSI/AWWA C151/A21.51, Class 50, with asphalt coating and cement mortar lining unless otherwise shown or specified.

A. Joints shall be push-on or mechanical joints conforming to ANSI/AWWA C111/A21.11.

B. Fittings and specials shall be suitable for 150 pounds per square inch pressure rating, unless otherwise specified. Fittings and specials for mechanical joint pipe shall conform to C153/A21.53.

C. Linings for pipe and fittings shall be standard thickness cement-mortar in accordance with ANSI/AWWA C104/A21.4.

D. Outside Coating: The outside coating shall be a minimum of 1 mil bituminous paint according to ANSI/AWWA C151/A21.51 Section 51-8.1.

2.01.3 POLYVINYL CHLROIDE (PVC) PIPE AND HIGH DENSITY POLYETHYLENE (HDPE) PIPE:

HDPE mains: Pipe shall be 2-inch, SDR 9, 200 psi, and will be used for directional drilling as directed by the Authority.

2-inch PVC mains: Pipe shall be ASTM D2241, IPS, Gasketed Pipe, SDR 21 and shall bear the seal of NSF.

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4-inch – 12-inch PVC mains: Pipe shall conform to requirements of AWWA C900 Class 150 (DR 18). Pipe shall bear the seal of NSF. Joints shall conform to ASTM D3139 or ASTM D3212.

14-inch – 36-inch PVC mains: Pipe shall conform to requirements of AWWA C905 Class 235 (DR18). Pipe shall bear the seal of NSF. Joints shall conform to ASTM D3139 or ASTM D3212.

2.01.4 FITTINGS AND SPECIALS: Fittings and specials shall be class 54 ductile iron, mechanical joint in accordance with ANSI/AWWA C111/A21.11, ANSI/AWW A C153/A21.53, 150 pounds per square inch pressure rating unless otherwise shown or specified, except that profile of bell may have special dimensions as required by the pipe manufacturer with elastomeric gaskets. Ductile iron fittings and specials shall be cement- mortar lined (standard thickness) in accordance with ANSI/AWWA C104/A21.4. Fittings shall be for bell and spigot pipe.

2.01.5 SERVICE LINE PIPING: Pipe shall be polyethylene (PE) tubing, SDR 9, 200 psi, conforming to ASTM D2737/AWWA C901. No joint shall be installed between the main service tap and the meter stop.

2.01.6 MECHANICAL JOINT RESTRAINT GLAND:

A. Mechanical joint restraint shall be incorporated in the design of the follower gland and shall include a restraining mechanism which, when actuated, imparts multiple wedging action against the pipe, increasing its resistance as the pressure increases. Flexibility of the joint shall be maintained after burial.

B. Glands shall be manufactured of ductile iron conforming to ASTM A536-80. Restraining devices shall be of ductile iron heat treated to a minimum hardness of 370 BHN. Dimensions of the gland shall be such that it can be used with the standardized mechanical joint bell and tee-head bolts conforming to ANSI/AWWA A21.11 and ANSI/AWWA C153/A21.53 of latest revision. Twist- off nuts shall be used to insure proper actuating of the restraining devices.

C. The Mechanical joint restraint device shall have a working pressure of at least 250 psi with a minimum safety factor of 2:1.

D. Restraint glands shall be "Megalug" as manufactured by EBAA Iron, Inc., or "Camlok" as manufactured by Smith-Blair, Inc.

2.01.7 PACKING MATERIALS AND JOINTS: No contaminated material or any material capable of supporting prolific growth of micro-organisms shall be used for sealing joints.

The lubricant used in the installation of sealing gaskets shall be suitable for use in potable water and shall conform to AWWA C111/A21-11. It shall be delivered to the job in enclosed containers and shall be kept clean.

2.02 VALVES

2.02.1 VALVES: Iron body, bronze mounted, double disc, parallel seat type meeting the full requirements of AWWA C500, or resilient seated in conformance with AWWA C509 or C515, with a minimum working pressure of 150 pounds per square inch. Valves larger than 16-inches shall be butterfly valves. Valves shall have 2-inch operating nut and open left, and shall have 0-ring seals. Valve ends shall be mechanical joint, unless otherwise shown or specified. Valves shall be manufactured by Mueller, American Darling or Clow Corporation or approved equal.

2.02.2 VALVE BOXES: Valve boxes shall be cast iron screw adjustment type with flared base. The word "WATER" shall be cast in the cover. The boxes shall be of such length as will be adapted, without full extension, to the depth of cover required over the pipe at the valve location. Boxes shall be installed over each gate valve, unless otherwise shown or specified. Valve boxes shall conform to ASTM A48 "Grey Iron Castings" Class 30B or approved equal.

2.02.3 VALVE BOX CONRETE COLLARS: Valve boxes in unpaved areas shall be installed with either pre-cast or poured in place concrete collars.

2.03 FIRE HYDRANTS: Hydrant valves shall open left. Hydrants shall be iron body, fully bronze mounted, dry barrel type with breakaway flange and stem coupling conforming to AWWA C502, with valve opening not less than 4.5-inches in diameter. Hydrants shall have a 6-inch mechanical joint connection on the inlet end. Outlets shall have American National Standard fire hose coupling threads. Working parts shall be bronze. Hydrants shall be Mueller, American Darling or approved equal.

2.04 WATER SAMPLING STATIONS: Sampling stations shall be installed on all 2-inch or larger services and mains or as directed by the Authority. The sampling station shall be installed immediately downstream of the reverse backflow preventer or as directed by the Authority. The sampling station shall be the Eclipse No. 88 model, by the Kupferle Foundary Company, or approved equal, and will be installed per Authority Specifications. A ground collar shall be placed around the sampling station and embedded to a minimum depth of 6-inches and the annular space between the ring and sampling station shall be filled with washed stone, #57 or equivalent.

2.05 SERVICE LINE ITEMS

2.05.1 SERVICE TAPS – 1 INCH AND 1 ½ INCH

A. Service Saddles: Saddles for PVC main shall be wide band brass body service saddles, McDonald 3800 series, Mueller H 13000 series, or approved equal. Saddles for ductile iron pipe shall be Rockwell Model 313 or approved equal.

Size of tap shall match that of the service line (1-inch minimum tap).

B. Corporation Stop: Connection stop shall have compression nut and gasket service line connections. Size of corporation stop shall match that of service line. Corporation stop shall be McDonald Model 4701-22, Mueller Model P-15008, or approved equal. Stainless steel insert stiffeners, 1-inch diameter, McDonald Part Number 6133T or approved equal shall be used on all compression fittings.

C. Threads: shall be corporation cock threads.

2.05.2 SERVICE TAPS – 2-INCH

A. Service Saddles: Saddles for PVC mains shall be wide band, 2 pieces, brass body (McDonald Series 3800) or bronze body (Mueller Series H-13000). No three piece service saddles are permitted.

B. Tapping Valve: The tapping valve shall be a 2-inch, Resilient Wedge Gate Valve, Mueller A-2360 or approved equal.

C. Valve Boxes: A valve box as specified in Section 2.02.2 shall be installed with the 2-inch tapping valve.

2.05.3 SINGLE SERVICE LINE

A. Compression Adapter Fittings: Service stops shall have compression adapter fitting for connection to 1-inch diameter (minimum) PE water service line and shall be McDonald Model 4753-22 or approved equal. Stainless steel insert stiffeners, 1-inch diameter, McDonald Part Number 6133T or approved equal shall be used on all compression fittings.

B. Service Angle Stops: Service stop shall have threaded fitting for connection to compression adapter and shall be McDonald Model 4604, or approved equal.

2.05.4 DUAL SERVICE LINE

A. U-Branch Fitting: Dual service connections shall be split using a U-branch fitting with compression fittings for connection to 1-inch or 1 ½-inch diameter PE service line. Branch shall be McDonald 08U2M with 71/2" spread, Mueller Model H-15365, or approved equal with 3/4-inch threaded connection for service stop. Stainless steel insert stiffeners, 1-inch diameter, McDonald Part Number 6133T or approved equal shall be used on all compression fittings.

B. Service Angle Stops: Service stop shall have threaded fitting for connection to U-branch and shall be McDonald Model 4604, or approved equal.

2.05.5 LARGE METER SETS AND STRAINERS

A. 1-½ inch and 2-inch meters shall be set in a McDonald Meter Setter, Series 775, sized per meter service size, or approved equal.

B. 3-inch and larger water meters shall have a separately mounted strainer basket assembly for trapping and removal of large particles, and a lockable bypass per Standard Detail.

2.05.6 WATER METER BOXES: Boxes shall be cast iron or plastic with cover complete with lifting lug and a metal read lid. Cast iron boxes conforming to ASTM A48, Class 30B, meeting H20 Loading Standards, shall be used in traffic areas. Single meter box shall be Model D1200-DICIR as manufactured by DFW/HPI or approved equal. Dual service line boxes shall be jumbo heavy duty boxes with solid lid and shall be Model D1500-DICIR as manufactured by DFW/HPI or approved equal.

2.05.7 WATER METER VAULTS: Water meter vaults shall be constructed of pre-cast concrete and sized to provide sufficient access for maintenance and protection of the meter and enclosed valves. The base of the vault shall be placed on 6" thick layer of #57 stone. The top of the meter vault shall be set 6-inches above grade.

The meter vault lid shall be able to be fully opened for access to the vault, lockable with stainless steel slam lock with a removable key, rain-tight aluminum, hatch of size and dimension as shown on drawings. At a minimum, the lid must be sized to allow unrestricted maintenance access for meter retrieval and reset. Hatches shall be manufactured by Halliday Products, Inc., or approved equal. Valves and meters within the vault shall be adequately supported to counteract their weight and all imposed dynamic loads. All water main piping within a minimum of 5' of vault shall be ductile iron.

If remote read is being used, the remote read head shall be mounted flush to the aluminum top and adjacent to the hinge so that the meter can be read with Authority equipment without opening the vault. Electronic wiring between the meter and the door mounted electronic remote read head shall have proper slack, be in a protective sheath, secured, and installed adjacent to the hinge to minimize entanglement and interference with door opening and maintenance access.

2.05.8 SERVICE INTENDED FOR FIRE PROTECTION: The Town of Kure Beach provides potable water service which may be interrupted for repairs, system expansion, or other general requirements. The Town of Kure Beach does not guarantee adequate fire flow for protection of life or property. Some facility owners choose to utilize this interruptible potable water supply from the Town of Kure Beach system for fire protection. If facility owners choose to utilize the potable water system for fire protection flow, the service for fire protection shall be configured in one of two methods:

2.05.8.1 METHOD 1: TWO TAPS

Two taps shall be installed, one for potable water and one for fire flow. The potable water tap shall be installed and metered in accordance with Section 2.05 SERVICE LINE ITEMS. All meters installed on lines greater than 2 inch diameter must have a strainer and be installed in an appropriately sized, approved meter vault that provides sufficient access for reading, maintenance, and protection in accordance with Section 2.05.7 Water Meter Vaults.

The fire flow tap shall not be metered and the fire flow system shall be fully segregated from the potable system throughout the facility. A privately owned, privately maintained reduce pressure (RP) zone backflow prevention device shall be installed in the line immediately after entering a structure in accordance with the North Carolina State Building Code and the Town of Kure Beach Cross Connection Control Ordinance.

2.05.8.2 METHOD II: ONE TAP

A single tap shall be installed with an Invensys FM-721 Compact Fireline Meter Assembly, or equal compatible with the Authority's electronic meter reading system. The meter will measure all high volume water flows and normal flows as low as 3 GPM with accuracy of +/- 1.5% of actual throughput and 95% at low flow.

The meter shall be installed in an appropriately sized, approved meter vault that provides sufficient access for reading, maintenance, and protection in accordance with Section

2.05.7 Water Meter Vaults.

A bypass line for fire flow with an approved post indicator valve (P.I.V.) shall be installed in the line to bypass the meter. An approved post indicator valve (P.I.V.) shall be installed in the bypass line. The P.I.V. shall be above-ground type with a locking handle and a prominent open/closed indicator window. The P.I.V. shall be protected by bollards if installed in, or immediately adjacent to, a paved area at the sole discretion of the Town of Kure Beach. A privately owned, privately maintained reduce pressure (RP) zone backflow prevention device shall be installed in the line immediately after entering a structure in accordance with the North Carolina State Building Code and/or the Town of Kure Beach Cross Connection Control Ordinance.

PART 3 EXECUTION

3.01 GENERAL: Install pipe in strict conformance with AWWA C600. Minimum depth of bury above the top of pipe shall be 36 inches unless ductile iron pipe is used. Install plastic pipe in conformance with ASTM D2774 and recommended practices of the UNI- BELL Plastic Pipe Association (www.uni-bell.org)

3.02 CUTTING OF PIPE: Cut pipe in a neat and workmanlike manner without damage to the pipe or its lining.

3.03 ADJACENT FACILITIES: Refer to Section 02731: Gravity Sanitary Sewer for adjacent facility locations.

3.04 JOINT DEFLECTION: Maximum joint deflection shall meet requirements of AWWA C600 or AWWA Manual of Practice M23.

3.05 PIPE LOCATOR WIRE: A 10 gauge insulated copper wire shall be run continuously along the pipe and shall be securely taped to the water line. All splices in the wire shall be made by use of an underground rated, watertight, and approved splice connector. No twisting of wire ends is permitted. The locator wire shall not be wrapped around the pipe, flanges, bells, valves, or other appurtenances. The locator wire shall be accessible above ground at one thousand feet (1,000') intervals and shall be protected by a cast iron

box with cover marked "water" with a concrete collar. At valve boxes, the wire shall be brought up on the outside of the box and folded under lid.

3.06 JOINTING OF PIPE

3.06.1 KEEPING PIPE CLEAN AND DRY: Precautions shall be taken to protect pipe interiors, fittings and valves against contamination. Pipe delivered for construction shall be strung so as to minimize entrance of foreign material.

When pipe laying is not in progress, for example, at the close of the day's work, all openings in the pipeline shall be closed by water-tight plugs. Joints of all pipe in the trench shall be completed before work is stopped. If water accumulates in the trench, the plugs shall remain in place until the trench is dry. It is recommended that only the amount of pipe to be installed that day be strung out.

NOTE:

Delay in placement of delivered pipe invites contamination. The more closely the rate of delivery is correlated to the rate of pipe laying, the less this delay. If the dirt will not be removed by the flushing operation in the opinion of the Engineer, the interior of the pipe shall be cleaned and swabbed as necessary, with a five (5%) percent hypochlorite disinfecting solution.

3.06.2 DUCTILE-IRON PIPE shall be installed in accordance with AWWA C600, modified as necessary by the recommendations of the manufacturer.

3.06.3 PVC PIPE shall be installed in accordance with AWWA Manual of Practice M23, modified as necessary by the recommendations of the manufacturer.

3.06.4 CONNECTIONS between different types of pipe and accessories shall be made with transition fittings approved by the Owner's Representative.

3.06.5 SERVICE LATERALS: Service laterals shall consist of a tapping saddle, corporation stop and a length of PE pipe with no joint installed between the main service tap and the service stop. Service laterals shall be installed perpendicular to the water main. Contractor shall install all material per the detail allowing for meter installation at a later date by Town of Kure Beach personnel.

3.07 SETTING OF VALVES, VALVE BOXES AND FIRE HYDRANTS

3.07.1 GENERAL: Install where shown or directed and set plumb on a brick foundation. Valve boxes shall be centered on the valves. Boxes shall be installed over each outside gate valve. Where feasible, valves shall be located outside the area of roads and streets. Earth fill shall be carefully tamped around each valve box to a distance of 4 feet on all sides of the box, or to the undisturbed trench face if less than 4 feet.

3.07.2 VALVES after delivery shall be drained to prevent freezing and shall have the interiors cleaned of all foreign matter before installation. Valves shall be fully opened and fully closed to insure that all parts are in working condition.

3.08 RESTRAINING AND BLOCKING

The plugs, caps, tees and bends deflecting 11 1/4 degrees or more either vertically or horizontally on water lines 6 inches in diameter or larger shall be provided with thrust blocking or "Megalug" or Camlok retainer gland at each joint, installed per manufacturer's requirements. Blocking shall be placed between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, the base and thrust bearing sides of the thrust blocks shall be poured directly against undisturbed earth. The sides of thrust blocks not subject to thrust may be poured against forms. The area of bearing shall be as shown on the plans or as directed. Blocking shall be placed so that the fitting joints will be accessible for repair. Steel rods and

clamps shall be stainless steel.

3.09 FIRE HYDRANTS: Locate and install as shown on the drawings. Each hydrant shall be connected to the main with a 6-inch branch line. Hydrants shall be set plumb with the pumper nozzle facing the roadway and with the center of the lowest outlet not less than18 inches above the finished surrounding grade and the operating nut not more than 48 inches above the finished surrounding grade. The hydrant shall be set in a bed of crushed rock which shall surround the barrel at least 12 inches in all directions. Hydrants shall be restrained with stainless steel tie rods extending from the main line tee to the hydrant, or by combination of tie rods and blocking or by "Megalug" retainer glands at each joint per manufacturer's requirements.

3.10 HYDROSTATIC TESTING

3.10.1 GENERAL: Where any section of a water line is provided with concrete thrust blocking, the hydrostatic test shall not be made until at least 5 days after installation of the concrete thrust blocking unless otherwise approved. The method proposed for disposal of wastewater from hydrostatic tests and disinfection shall be submitted to the Owner's representative prior to performing hydrostatic tests. Use clean potable water for all testing of lines.

3.10.2 PRESSURE TEST: Pressure test in strict conformance with AWWA C600, Section 4.1. For purposes of testing, working pressure shall be 100 psi and test pressure shall be 150 psi. Air testing will not be accepted (Only Hydrostatic Testing is allowed).

3.10.3 LEAKAGE TEST: Test for leakage concurrent with the pressure test and in strict conformance with AWWA C600, Section 4.2, Table 6 Allowable Leakage per 1000 ft (305 m) of Pipeline. Remedy all visible leaks and locate and repair leakage in lines which exceed the specified amounts.

3.11 DISINFECTION

3.11.1 DISINFECTING WATER MAINS

Each unit of constructed water main shall be disinfected with chlorine upon successful completion of the hydrostatic test. The disinfection procedure shall be performed in strict conformance with the Town of Kure Beach Procedures for Disinfecting Water Mains, as outlined below.

The Contractor shall pay particular attention to the scheduling requirements outlined in the procedures. The Contractor shall be responsible for furnishing and installing all required chlorine injection and monitoring ports at no additional cost to the Engineer, Owners Representative, or Town of Kure Beach.

The mains will in no case be accepted by the Town of Kure Beach for public use until the Town of Kure Beach Engineer approves the mains as having been properly disinfected.

3.11.2 PROCEDURES FOR DISINFECTING WATER MAINS

A. GENERAL INTENT

It is the intent of these procedures to present essential steps for disinfecting new and repaired water mains. All steps must be initiated and complied with in order for permission to be given for these water lines to be opened for use by Town of Kure Beach water customers. Pressure testing must be completed and approved before chlorination procedures are started. Engineer, Owners Representative, and Town of Kure Beach Engineering staff must have written confirmation of satisfactory completion of the pressure test before scheduling the chlorination.

B. BASIC PROCEDURES

The basic procedure comprises:

1. Preventing contaminated materials from entering the water mains during

construction or repair and removing by flushing materials that may have entered the water main.

2. Disinfecting any residual contamination that may remain.
3. Determining the bacteriological quality by laboratory test after disinfection.

C. STANDARD OF REFERENCE

All procedures herein shall comply with the AWWA Standard C615-92 for Disinfection of Water Mains or the latest revision.

D. CHLORINATION PLANNING

The planning process prior to chlorination involves checking the design plan for the correct installations and layout needed for chlorination, routing, the chlorine solution and numbering blowoff sample points, calculating the required amount of chlorine, and determining the required amount of time to properly chlorinate the system. Planning is necessary to ensure that newly installed pipes are chlorinated properly and safely.

Before calling Engineering office for a time to be set up for sterilization, all of the following must be installed or supplied by the Contractor at no cost to the Town of Kure Beach Also, this list should be checked and/or assembled before Engineering personnel arrive.

1. The line or lines to be sterilized should be connected to the Town of Kure Beach water system (main). A valve should be installed in the line to be sterilized near the Town of Kure Beach water main connection.
2. A blowoff of an approved material, or brass faucet should be installed at the dead end of the line and every 1,200 feet to be sterilized for flushing purposes and bacteria sampling. The opening to this blowoff should point downward, and there should be at least twenty-four inches clearance between the opening and the ground for proper sampling.
3. Copper or PVC blowoffs should be at all closed valves.
4. Mains connecting other mains with open valves within the system to be sterilized may cause "short circuits" resulting in improper sterilization. Valves on these connecting mains should be checked to see if they should be closed to eliminate this problem. Copper blowoffs should be at both sides of valves closed to prevent "short circuits".
5. Pressure test the line before attempting sterilization procedures.
6. A clean container is necessary to dissolve the "HTH".
7. A clean, wooden paddle should be present for mixing and dissolving the "HTH".
8. A pump for pumping the chlorine solution into the line should be present. This pump should be gasoline or electrically powered chemical feed pump designed for feeding chlorine solutions. For small applications, the solutions may be fed with a hand pump; for example, a hydraulic test pump. Feed lines shall be of such material and strength as to withstand safely the maximum pressures that may be created by the pumps. All connections shall be checked for tightness before the "HTH" solution is applied to the main.
9. All temporary blowoffs and injection points shall be properly abandoned and physically disconnected prior to the line being placed into service.

E. PRELIMINARY FLUSHING

Flushing is the process of flowing water through a pipe to remove foreign particles which could cause contamination or blockage within the water system. All mains should be flushed prior to chlorination. The minimum amount of water required to flush a main is 1 ½ times the capacity of the main (capacity and time may be calculated using the formulas below). A minimum velocity of 2.5 feed per second, but preferably

3.5 feet per second, should be maintained within the pipe to ensure that it is properly scoured. Not site for flushing should be chosen unless it has been determined that drainage is adequate for this site.

NOTE:

Flushing is no substitute for preventative measures taken before and during pipe laying. Certain contaminants, especially in caked deposits, resist flushing at any velocity. Furthermore, with diameters of 16 inches, even the minimum recommended flushing velocity of 2.5 feet/second is sometimes difficult to achieve.

Temporary blowoffs are a means of releasing water from a main for flushing. They are normally placed at "dead ends" and at each side of closed valves. A blowoff usually consists of a corporation stop, a length of pipe, and a curb stop at ground level; however, a blowoff on a large water main may consist of a gate valve and a length of pipe. A blowoff's size should be maintained when flushing the water main. Blowoffs are to be installed by the contractor installing the new water main. All permanent blowoffs shall be installed in accordance with standard details and

specifications.

F. FORM OF CHLORINE FOR DISINFECTION

Calcium Hypochlorite, commonly called "HTH" contains 70% available chlorine by weight. Granular "HTH" is packaged in containers of various types and sizes ranging from small plastic bottles to 100-pound drums. It is available at most chemical supply houses. A chlorine water solution is prepared by dissolving the granules in water in the proportion required for the desired concentration.

G. CHLORINATION CALCULATIONS

The amount of chlorine required to properly sterilize the system should be determined.

First, the volume of water within the new line should be calculated by using the following table:

Diameter of Line (Inches)	# Gal/Ft
16	10.50
12	5.87
8	2.62
6	1.47
2	0.16

1. Multiply the # gal/ft for the size line by the length of line in feet. This will give you the number of gallons the pipe will hold.
2. Use the following formula to determine the pounds of chlorine needed: 1

$$\text{lbs chlorine} = \frac{\text{\# gallons in the pipe} \times 417}{1{,}000{,}000}$$

3. Use the following formula to determine the pounds of "HTH" needed: (HTH is only 70% available chlorine)

$$\text{lbs HTH} = \frac{\text{lbs of chlorine}}{0.70}$$

The time required to fill the system with chlorine should be determined as well as the separate times for the chlorine to reach each blowoff. These time calculations will tell the chlorination crew approximately when each pipe is chlorinated.

The rate of flow in gallons per minute (gpm) may be determined as follows:

1. Each 3/4-inch blowoff gives an average flow rate of 40 gpm.
2. Each 1-inch blowoff gives an average flow rate of 70 gpm.
3. Each 2-inch blowoff gives an average flow rate of 250 gpm.

Time may be calculated by: T = gal gpm

Where T is time in minutes, gal is the number of gallons within the pipe, and gpm is the gallons per minute rate of flow.

The number of gallons of chlorine solution may be determined by:

$$S = T \times Pr$$

Where S is the number of gallons of chlorine solution, T is the time (min) required to totally chlorinate the system, and Pr is the rate (gpm) at which the solution is pumped into the system.

H. CHLORINATION APPLICATION

Due to time factors, line sterilization can only be initiated after being scheduled with the Engineering Department.

1. Chlorination is the process in which a concentrated solution of chlorine is injected into water mains for sterilization. Caution during the handling and injection of the chlorine solution is imperative because chlorine is very toxic and any error could be harmful to the public as well as the chlorination crew. Mix the calculated number of pounds or more of "HTH" in a quantity of water that will take into account the pumping capacity of the pump and the length of the pipe. Have extra "HTH" and a water source handy to mix more solution in case the level of solution drops to near empty before the technician signals for everything to be shut off.
2. Crack open the valve just enough to allow water from the Town of Kure Beach main to enter the line to be sterilized and flow at a constant rate.
3. After all the air is purged from the line and the water is flowing slowly, constantly, and evenly, begin pumping "HTH" into the blowoff near the valve. The Chief Engineer will monitor the chlorine levels at the other end of the line until he obtains at least 50 ppm chlorine. At this point, he will signal for both the valve to the Town of Kure Beach main and the chlorine pump to be shut off at the same time.
   IT IS VERY IMPORTANT THAT THE VALVE TO THE TOWN OF KURE BEACH MAIN IS SHUT TIGHTLY SO THAT NO HIGHLY CHLORINATED WATER FLOWS BACK INTO THE SYSTEM ALREADY IN SERVICE TO THE PUBLIC.
4. During the application of the chlorine, valves shall be adjusted to prevent the treatment dosage from flowing back into the line supplying the water. Chlorine application shall not cease until the entire main is filled with chlorine solution. This will ensure that the entire length of pipe will be filled with at least 50 part per million chlorine solution. The chlorinated water shall be retained in the main for at least twenty-four hours, during which time all valves and hydrants in the section treated shall be operated in order to disinfect the appurtenances.
5. After a twenty-four (24) hour contact period, the chlorine residual will again be checked by a laboratory technician. If at this time the chlorine residual drops below 25 parts per million and/or the total chlorine drop in level is greater than 25 ppm, the line shall be re-sterilized as before. (Such a large drop in chlorine could indicate the presence of contaminating substances. It would be advisable to again flush the line thoroughly before attempting to re-chlorinate.)

I. FINAL FLUSHING

After the applicable retention period, the heavily chlorinated water shall be flushed from the main until the chlorine concentration in the water leaving the main is no higher than that generally prevailing in that section of the distribution system, or less than 1 mg/1. Chlorine residual determinations shall be made to ascertain that the heavily chlorinated water has been removed from the pipeline. FOR LARGE MAINS, THIS

FLUSHING COULD TAKE AS LONG AS 24 HOURS. Precautionary measures for dealing with environmental concerns shall be taken prior to disposal of large volumes of water.

J. BACTERIOLOGICAL TESTS

After final flushing, before the water main is placed in service, samples shall be collected from the end of the line and tested and, if it is a large main, from several blowoffs evenly spaced along the line. These samples shall be analyzed for bacteriological quality and shall show the absence of coliform organisms before the line is placed in service. The presence of coliform on these tests require the line be re-sterilized. These samples require forty-eight hours incubation time from the time of sample pickup. After this time, contractors may call the water plant laboratory for results.

Samples for bacteriological analysis shall be collected in sterile bottles treated with sodium thiosulfate. No hose or fire hydrant shall be used in collection of samples. A suggested sampling tap consists of a standard corporation cock installed in the main with a copper tube gooseneck assembly. After samples have been collected, the gooseneck assembly may be removed and retained for future use.

NOTE: If the initial disinfection fails to produce satisfactory samples, disinfection shall be repeated until satisfactory samples have been obtained. When the samples are satisfactory, the main may be placed in service.

3.11.3 PROCEDURE AFTER CUTTING INTO OR REPAIRING EXISTING MAINS

The procedures outlined in this section apply primarily when mains are wholly or partially dewatered. Leaks or breaks that are repaired with clamping devices while the mains remain full of water under pressure present little danger of contamination and require no disinfection.

A. Trench "Treatment". When an old line is opened, either by accident or by design, the excavation will likely be wet and badly contaminated from nearby sewers. Liberal quantities of hypochlorite applied to open trench areas will lessen the danger from such pollution. Tablets have the advantage in such a situation because they dissolve slowly and continue to release hypochlorite as water is pumped from the excavation.

B. Main Disinfection

1. Swabbing, Flushing and Sampling. The following procedure is considered as a minimum that may be used.

a. Swabbing with hypochlorite solution. The interior of all pipe and fittings used in making repair (particularly couplings and tapping sleeves) shall be swabbed with a five (5) percent hypochlorite solution before they are installed.

b. Flushing. Thorough flushing is the most practical means of removing contamination introduced during repairs. If valving and hydrant locations permit, flushing from both directions is recommended. Flushing shall be started as soon as the repairs are completed and continued until discolored water is eliminated.

c. Sampling. Bacteriological samples shall be taken after repairs to provide a record by which the effectiveness of the procedures can be determined. If the direction of flow is known, sample locations shall be determined. If the direction of flow is unknown, samples shall be taken on each side of the main break.

3.11.4 SPECIFICATIONS FOR DISINFECTION OF WATER DISTRIBUTION MAINS

A. GENERAL

1. Scope

This standard presents essential procedures for disinfecting new and repaired

water mains. All new water mains shall be disinfected before they are placed in service. All water mains taken out of service for inspection, repair, or other activities shall be disinfected before they are returned to service.

2. References

This standard references the following documents. The latest current edition of each forms a part of this standard where and to the extent specified herein. In case of any conflict, the requirements of this standard shall prevail.

ANSI/AWWA C651 - 92	Disinfecting Water Mains
ANSI/AWWA B300	Standard for Hypochlorites AWWA
Manual - M3	Safety Practices for Water Utilities
AWWA Manual - M20	Water Chlorination Principles and Practices
AWWA Manual - M12	*Simplified Procedures for Water Examination*
APHA, AWWA, WEF *Water and Wastewater*	*Standard Methods for the Examination of*

3. Records of Compliance

The records of compliance shall be the following:

Coliform Bacteria: Zero coliforms per 100 ml sample

Chlorine Residual: Chlorine residual equivalent to the source water concentration

B. FORMS OF CHLORINE TO BE USED

The forms of chlorine that are to be used for the purpose of disinfection operation or water main repairs are sodium hypochlorite solution or calcium hypochlorite granules.

1. Sodium Hypochlorite

Sodium hypochlorite conforming to ANSI/AWWA B300 is available in liquid form. Sodium hypochlorite contains approximately 5 to 15 percent available chlorine and care must be taken to control conditions and length of storage to minimize its deterioration.

2. Calcium Hypochlorite

Calcium hypochlorite conforming to ANSI/AWWA B300 is available in granular form and contains 65 percent available chlorine by weight. This material must be stored in a cool, dry, and dark environment to minimize deterioration.

C. BASIC DISINFECTION PROCEDURES

The basic disinfection procedure consists of:

1. Preventing contaminating materials from entering the water main during storage, construction, or repair.
2. Removing by flushing or other means, those materials that may have entered the water main.
3. Chlorinating any residual contamination that may remain, and flushing the chlorinated water from the main.
4. Protecting the existing distribution system from backflow due to hydrostatic pressure test and disinfection procedures.
5. Determining the bacteriological and other related quality by laboratory testing after disinfection.
6. Final connection of the approved new water main to the active distribution system.

D. PREVENTIVE AND CORRECTIVE MEASURES DURING CONSTRUCTION

Heavy particulates generally contain bacteria and prevent even very high chlorine concentrations from contacting and killing such organisms. It is, therefore, essential that the procedures of this section be observed to assure that a water main and its appurtenances are thoroughly clean for the final disinfection by chlorination. Also, any

connection of a new water main to the active distribution system prior to receipt of satisfactory samples may constitute a cross-connection. Therefore, the new main must be isolated until tests described in Section 7.0 are satisfactorily completed.

1. Keeping Pipe Clean and Dry
   Precautions shall be taken to protect the interiors of pipes, fittings, and valves against contamination. Pipe delivered for construction shall be strung so as to minimize the entrance of foreign material. All openings in the pipeline shall be closed with watertight plugs when work is stopped at the end of the day or for other reasons.
2. Joints
   Joints of all pipes in the trench shall be completed before work is stopped. If water accumulates in the trench, the plugs shall remain in place until the trench is dry.
3. Packing Material
   All packing material shall consist of molded or tubular rubber rings, or other approved material. Lead or asbestos material in any form shall not be permitted.
4. Sealing Materials
   No contaminated material or any material capable of supporting prolific growth of microorganisms shall be used for sealing or lubricating joints. Sealing and lubricating material or gaskets shall be handled in a manner that avoids contamination. The lubricant used in the installation of sealing gaskets shall be suitable for use in potable water. It shall be delivered to the job in closed containers and shall be kept clean.
5. Cleaning of Pipe and Appurtenances
   If dirt enters the pipe, it shall be removed and the interior pipe surface cleaned. If, in the opinion of the Town of Kure Beach's approving representative, the dirt remaining in the pipe will not be removed by the flushing operation, then the interior shall be cleaned by mechanical means such as a hydraulically propelled foam pig or other suitable device. The cleaning method used shall not force mud or debris into the interior pipe joint spaces and shall be acceptable to the Town of Kure Beach.
6. Flooding by Storm or Accident during Construction
   If the main is flooded during construction, it shall be cleared of the floodwater by draining and flushing with potable water until the main is clean. The section of pipeline shall be flushed until water from the pipe runs clear.

E. METHOD OF CHLORINATION

The contractor shall use the continuous feed method for disinfection of all new water mains. This method must give a minimum of 10 mg/L of chlorine residual at the end of the 24-hr period.

1. Continuous-Feed Method
   The continuous-feed method is the process in which a concentrated solution of chlorine is injected into the water main. Caution shall be observed during the handling and injection of the chlorine solution as chlorine in any form is very toxic and any error could be harmful to the employees and to the public.
2. Preliminary Flushing
   Prior to any disinfection procedures being performed, all hydrostatic tests shall have been completed and accepted by the Engineer, Owners Representative, and Town of Kure Beach. Before chlorine solutions are injected, the main shall be filled with potable water to eliminate air pockets and shall be flushed to remove particulates. The flushing velocity in the main shall not be less than 2.5 ft/sec (preferably 3.5 ft/sec) unless the Engineer, Owners Representative, or Town of Kure Beach determines that conditions do not permit the required flow or that the flow will cause undue problems when discharged to waste. An acceptable flushing velocity shall then be determined and

used.

3. Procedure for Chlorinating the Main

a. Water supplied from the existing distribution system or other approved public water supply shall be made to flow at a constant, measured rate into the newly installed water main. In the absence of a meter, the rate may be approximated as best can be determined.

b. At a point not more than 10 ft downstream from the beginning of the new main, water entering the new main shall receive a dose of chlorine fed at a constant rate such that the water will have not less than 50 mg/L and not greater than 100 mg/L free chlorine residual. To ensure that this concentration is provided, measure the chlorine concentration at regular intervals of distance and time in accordance with the procedures described in the current edition of *Standard Methods for the Examination of Water and Wastewater* or AWWA Manual M12, or by using appropriate chlorine test kits (see appendix B).

c. During the application of the chlorine, valves shall be adjusted by or under the supervision of the Town of Kure Beach's epresentative to prevent the chlorine solution from flowing back into the existing water system. The chlorine injection shall not cease until the entire water main is filled with a chlorine concentration of not less than 50 mg/L. All appurtenances and valves shall be operated to ensure that the chlorine solution has contact with them. The chlorinated water shall be allowed to remain for a period of not less than 24-hours.

d. At the end of the 24-hour period, the chlorine residual shall be measured and shall not be less than 10 mg/L in any samples collected along the water main and at the end of said water main.

F. FINAL FLUSHING

1. Clearing the Main of Highly Chlorinated Water

Highly chlorinated water should not remain in prolonged contact with pipe. At the end of the 24-hour contact period, the water should be removed in order to prevent damage to the pipe lining or corrosion damage to the pipe itself. The highly chlorinated water shall be flushed from the main until chlorine measurements show that the concentration in the water leaving the main is no higher than that generally prevailing in the distribution system.

2. Disposing of Highly Chlorinated Water

A neutralizing chemical shall be applied to the chlorinated water to be discharged to neutralize thoroughly the chlorine residual remaining in the water (see appendix B). Where necessary, federal, state, and local regulatory agencies should be contacted to determine special provisions for the disposal of the neutralized water.

G. BACTERIOLOGICAL AND OTHER TESTS

1. Standard Conditions

After final flushing and before the new main is opened to the distribution system, two consecutive sets of acceptable samples, taken at least 24-hours apart, shall be collected from the new main. Samples shall be collected from every 1200-ft of new water main, from the end of the water line, and from each branch. All samples shall be tested in accordance with *Standard Methods for the Examination of Water and Wastewater*. All samples shall show the absence of coliform organisms, a turbidity of less than 1.0 NTU, a heterotrophic plate count of less than 50 colonies per ml, a free chlorine residual equal to the level present in the existing system and shall have no visible color or particulate matter.

2. Special Conditions

If in the opinion of the Engineer, Owners Representative, or Town of Kure Beach, excess contamination has been allowed to enter the water main during construction or other events, bacteriological samples shall be taken at intervals of approximately 400

to 500 ft and shall be identified by location. Samples shall be taken of water that has stood in the new main for at least 16 hours after final flushing has been completed.

3. Sampling Procedures

A copper or PVC assembly or a combination blowoff and sampling tap may be used for mains up to 8-inches diameter. Fire hydrants may not be used for sampling purposes. After samples have been collected, analyzed, and accepted, the sampling assemblies may be removed and retained for future use. All bacteriological and turbidity analysis must be completed by a N.C. certified Drinking Water laboratory. All samples will be collected or directed to be collected by the Town of Kure Beach's authorized representative at times determined in advance. The water main contractor shall be responsible for all costs associated with the sampling and analysis of all samples required for acceptance.

H. REPEAT DISINFECTION OF WATER MAIN

If the initial disinfection fails to produce satisfactory results, the new main shall be reflushed and shall be resampled. If check samples also fail to produce acceptable results, the new main shall be rechlorinated by the continuous-feed method of chlorination until satisfactory results are obtained.

NOTE: High velocities in the existing system, resulting from flushing the new main,

may disturb sediment that has accumulated in the existing mains. When check samples are taken, it is advisable to also sample water entering the new main.

I. CONNECTION TO EXISTING SYSTEM

The final acceptance and opening of valves to the existing water system will only be allowed after satisfactory samples and chlorine levels have been produced. All sampling devices and blowoffs must be removed from the water main by the contractor prior to acceptance by the Town of Kure Beach.

J. DISINFECTION PROCEDURES WHEN CUTTING OR REPAIRING EXISTING MAINS

The following procedures apply primarily when mains are wholly or partially dewatered. After the appropriate repair procedures have been completed, the existing main may be returned to service prior to completion of the bacteriological testing to minimize the time customers are out of water. Leaks or breaks that are repaired with clamping devices while the mains remain full of pressurized water present little danger of contamination and require no disinfection.

1. Swabbing with Hypochlorite Solution

The interior of all pipe and fittings (particularly couplings and sleeves) used in making the repair shall be swabbed with a 5 percent hypochlorite solution before they are installed.

2. Flushing

Thorough flushing is the most practical means of removing contamination introduced during repairs. If valve and hydrant locations permit, flushing toward the work location from both directions independently is recommended. Flushing shall be started as soon as the repairs are completed and shall be continued until discolored water and particulate matter are eliminated.

3. Slug Chlorination

When practical, in addition to the procedures above, the section of main in which the break is located shall be isolated, all service connections shut off, and the section flushed and chlorinated with a high concentration of chlorine (as much as 300 mg/L), and the concentration allowed to stay in contact with the main for a minimum of 15 minutes. After chlorination, flushing shall be resumed and continued until discolored water is eliminated and the water is free of noticeable high chlorine odor. A chlorine residual of no greater than 3.0 mg/L shall be acceptable.

4. Sampling

Bacteriological samples shall be taken or shall be directed to be taken by the

Engineer, Owners Representative, or Town of Kure Beach authorized representative after repairs are completed to provide a record for determining the procedure's effectiveness. If the direction of flow is unknown, then samples shall be taken on each side of the main break. If bacteriological samples are unacceptable, the Engineer, Owners Representative, or Town of Kure Beach authorized representative will determine corrective action. Daily sampling shall be continued until two successive daily samples are acceptable.

K. CHLORINE RESIDUAL TESTING

Several manufacturers produce high-range and low-range chlorine test kits that are inexpensive, easy to use, and satisfactory for the precision required. The test kits should use methodology conforming with *Standard Methods for the Examination of Water and Wastewater* or AWWA Manual M12. Examples of such manufacturers include:

- Hach Company
- LaMotte
- Fisher Scientific Hellige

L. DISPOSAL OF HIGHLY CHLORINATED WATER

Chlorine residual of water being disposed will be neutralized by treating with one of the chemicals listed below:

- Ascorbic Acid
- Sulfur Dioxide
- Sodium Bisulfate
- Sodium Sulfite
- Sodium Thiosulfate

END OF SECTION 331413

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SECTION 33 14 14

PUBLIC WATER SERVICE CONNECTIONS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe and fittings for water service connections to small commercial, light industrial, and residential homes 2" service and smaller.
   2. Corporation stop assemblies.
   3. Curb stop assemblies.
   4. Backflow preventers.
   5. Meter setting equipment.
   6. Meter boxes.
   7. Trenching, bedding, and cover.

B. Related Requirements:
   1. CFPUA Material Specification Manual (MSM).
   2. Section 31 23 34.01 – Excavating, Trenching, Dewatering and Backfilling.
   3. Section 33 14 13 – Water Distribution Piping and Appurtenances.
   4. Section 33 14 13 – Water Distribution Valves and Fire Hydrants.
   5. Section 33 14 20 – Disinfection of Water Distribution Mains.
   6. Section 33 05 13 – Precast Concrete Manholes and Utility Structures.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:
   1. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. American Society of Mechanical Engineers:
   1. ASME B16.18 – Cast Copper Alloy Solder Joint Pressure Fittings.
   2. ASME B16.22 – Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

C. American Society of Sanitary Engineering:
   1. ASSE 1012 – Performance Requirements for Backflow Preventers with an Intermediate Atmospheric Vent.

2. ASSE 1013 – Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers.

D. ASTM International:
1. ASTM B62 – Standard Specification for Composition Bronze or Ounce Metal Castings.
2. ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3).
3. ASTM D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3).
4. ASTM D2737 - Standard Specification for Polyethylene (PE) Plastic Tubing.
5. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
6. ASTM D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

E. American Welding Society:
1. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding.

F. American Water Works Association:
1. AWWA C509 – Resilient-Seated Gate Valves for Water Supply Service.
2. AWWA C600 – Installation of Ductile-Iron Mains and Their Appurtenances.
3. AWWA C800 – Underground Service Line Valves and Fittings.
4. AWWA C901 – Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. (13 mm) Through 3 In. (76 mm), for Water Service.
5. AWWA M6 – Water Meters – Selection, Installation, Testing, and Maintenance.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Any event requiring a Town of Kure Beach representative to be present shall require a minimum of 2 business day notice to schedule the event.

B. No main valves are to be operated unless a Town of Kure Beach representative is present.

1.4 SUBMITTALS

A. Section 01 33 00 – Submittal Procedures.

B. Informational Submittals:
1. Product Data: Submit manufacturer information regarding pipe materials, pipe fittings, corporation stop assemblies, curb stop assemblies, meters, meter setting equipment, service saddles, backflow preventers, and accessories.
2. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
3. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

C. Action Submittals:
   1. Test Reports: Submit all the results of the bacteriological tests to the CFPUA Engineering Inspector.
   2. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
   3. Qualifications Statement:
      a. Submit qualifications for manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 – Execution and Closeout Requirements.

B. Project Record Documents: Record actual locations of piping mains, curb stops, connections, thrust restraints, pressure-pipe centerline elevations, and gravity-pipe invert elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.6 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

B. Perform Work according to CFPUA standards and details.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 – Product Requirements.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.

PART 2 PRODUCTS

2.1 MATERIAL SPECIFICATION MANUAL

A. Refer to Town of Kure Beach Material Specifications.

2.2 CURB STOP ASSEMBLIES

A. For ⅝-inch through 2-inch services provide a CTS inlet X Female iron pipe thread curb stop on CTS line 3" from inlet of meter setter.

2.3 WATER METERS SINGLE SERVICE

A. Meter box shall be installed flush with grade. Box shall be sized and centered around the meter assembly to allow for access and future maintenance.

2.4 DUAL SERVICE

A. Meter box shall be installed flush with grade. Box shall be sized and centered around the meter assembly to allow for access and future maintenance.

B. U-branch shall be installed prior to meter setter.

C. Meter setter shall be installed to allow three (3) to six (6) inches from top of meter from bottom of lid.

D. Meter setter shall be installed in the upright position.

2.5 MATERIALS

A. Bedding: As specified in Section 31 23 34.01 – Excavating, Trenching, Dewatering and Backfilling.

B. Cover: As specified in Section 31 23 34.01 – Excavating, Trenching, Dewatering and Backfilling.

C. Soil Backfill from Above Pipe to Finish Grade: As specified in Section 31 23 34.01 – Excavating, Trenching, Dewatering and Backfilling.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 – Execution and Closeout Requirements.

B. Verify that building service connections and municipal utility water main sizes, locations, and inverts are as indicated on Shop Drawings.

3.2 PREPARATION

A. Section 01 70 00 – Execution and Closeout Requirements.

B. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, and remove burrs.

C. Remove scale and dirt from inside and outside of piping before assembly.

3.3 INSTALLATION

A. 1-inch Service Corporation Stop Assemblies:
   1. Make connection for each different kind of water main, using suitable materials, equipment, and methods as approved by Engineer.
   2. Provide service clamps for mains constructed of materials other than cast iron or ductile iron.
   3. Location:
      a. Locate and stagger corporation stops at least 36 inches apart longitudinally.
   4. Plastic Pipe Mains:
      a. Provide full support for service clamp for full circumference of pipe, with minimum 2-inch width of bearing area.
      b. Exercise care against crushing or causing other damage to mains at time of tapping or installation of service clamp or corporation stop.
   5. Use seals or other devices such that no leaks are present in mains at points of tapping.
   6. Do not backfill and cover service connections until installation has been approved by Engineer and CFPUA inspector.

B. Bedding:
   1. Excavate pipe trench as specified in Section 31 23 34.01 – Excavating, Trench-ing, Dewatering, and Backfilling.
   2. Placement:
      a. Place bedding material as indicated on Drawings.
      b. Level fill materials in one continuous layer not exceeding 8 inches of compacted depth.
      c. Compact to 95 percent maximum density.
   3. Place fill materials as specified in Section 31 23 34.01 – Excavating, Trenching, Dewatering and Backfilling.

C. Pipe and Fittings:
   1. Maintain separation of water main from sewer piping according to code.
   2. Group piping with other Site piping Work whenever practical.
   3. Install pipe to allow for expansion and contraction without stressing pipe or joints.
   4. Install access fittings to permit disinfection of water system.
   5. Jointing of Pipe:
      a. Connections between different types of pipe and accessories shall be made with transition fittings approved by Town of Kure Beach representative.
      b. Service laterals shall consist of a tapping saddle, corporation stop and a length of PE pipe with no joint installed between the main service tap and the service stop. Service laterals shall be installed perpendicular to the water main. Contractor shall install all material per the Town of Kure Beach Material Specifications. Locator wire shall be installed as per specifications.
   6. Thrust Restraints: Form and place concrete for thrust restraints at each elbow or change of direction of pipe.
   7. Establish elevations of buried piping with not less than three (3) feet of cover.
   8. Pipe Markers: According to CFPUA MSM.
   9. Backfill trench as specified in Section 31 23 34.01 – Excavation, Trenching, Dewatering and Backfill for Pipes.

D. Curb Stop Assemblies:
   1. Set curb stops on 95% compacted soil.

E. Water Meters: 2-inch and smaller shall meet Town of Kure Beach Specifications.

F. Backflow Preventers:

1. Install backflow preventers where indicated on Drawings and according to manufacturer instructions.
2. Testing and Installation Requirements: Comply with Town of Kure Beach requirements and plumbing codes.

G. Service Connections:

1. Install water service according to as indicated on Drawings.
2. Install water service to 18" of right-of-way and connect to building water service as specified in CFPUA details and referenced in CFPUA Material Specification Manual.
3. All meters installed on lines greater than 2-inch diameter must have a strainer and be installed in an appropriately sized, approved meter vault that provides sufficient access for reading, maintenance, and protection in accordance with Water Meter Vaults specification.

H. Service Intended for Fire Protection:

1. Two taps shall be installed, one for potable water and one for fire flow. The potable water tap shall be installed and metered in accordance with this Section. The fire flow tap shall not be metered, and the fire flow system shall be fully segre-gated from the potable system throughout the facility. A valve will be installed at the tap and the right-of-way or easement line denoting the CFPUA owned/privately owned boundary. A privately owned, privately maintained back-flow prevention device shall be installed in the line immediately after entering a structure in accordance with the North Carolina State Building Code and the CFPUA Cross Connection Control Ordinance.

I. Pipe Locator Wire: As specified in Section 33 01 12 – Identification for Utilities Piping.

J. Disinfection of Water Piping System: Flush and disinfect system as specified in Section 33 14 20 – Disinfection of Water Distribution Mains.

3.4 TOLERANCES

A. Install pipe to indicated elevation to within tolerance of 1-inch. 3.5 FIELD QUALITY CONTROL

3.5 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements

B. Pressure test water distribution system according to Section 33 05 05.31– Hydrostatic Testing of Water Distribution and Sanitary Sewer Force Mains.

C. If tests indicate Work does not meet specified requirements, remove Work, replace, and retest.

END OF SECTION

SECTION 331422 – TESTING OF SANITARY SEWER MAINS AND MANHOLES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes testing and inspection of gravity sewer main, manholes, and service laterals in accordance with NCDEQ and Town of Kure Beach requirements. Location or project specific testing requirements and procedures shall be set forth by Town of Kure Beach and Engineer in approval conditions. CCTV shall be required as a minimum. Additional Testing may be requested.

B. Sewer mains, service laterals, and manholes shall be inspected and tested in accordance with the reference standards and following table with notes.

	CCTV Inspection	Low Pressure Air Test	Exfiltration Test	Deflection Test	Infiltration/Ex-filtration Limit	Vacuum Test
Sewer Mains	Yes	Yes (Note 1)	Yes (Note 2)	Yes (Note 3)	100 gpdim (Note 4)	
Sewer Laterals	Yes	Yes (Note 1)			100 gpdim (Note 4)	
Manholes	Yes					Yes (Note 5)

Notes:

1. When sewer main diameters are 24-inches and smaller; unless water table is 2-feet or more above the top of pipe at upstream end of main or the calculated air test pressure is greater than 9 psi.
2. When sewer main diameters are greater than 24-inches.
3. Mandrel pull test after backfill is placed and stable at grade for 30-days. As an alternative to waiting 30-days to permit stabilization of the soil-pipe system, certified test results from an independent testing firm verifying that the backfill of the trench has been compacted to a least 95% maxi- mum density may be accepted by Town of Kure Beach.
4. 100-gallons per nominal diameter-inch-mile for section tested and under 2-feet positive head.
5. Not applicable to existing manholes modified or rehabilitated.
6. Vertical compaction testing shall be performed at two (2) feet above the pipe and be completed in 2 ft lifts.
7. Horizontal compaction testing shall be performed at the tie-in point and every 100 ft thereafter.
8. Manhole compaction testing is to be performed in 2 ft lifts.

C. Related Requirements:
   1. Section 33 05 13 – Precast Concrete Manholes and Utility Structures. 2. Section 33 31 11 – Sanitary Sewer Gravity Mains.

1.2 REFERENCES

A. NC-DEQ Minimum Design Criteria for the Permitting of Gravity Sewers.

B. American Water Works Association:
   1. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances. 2. AWWA M23 – PVC Pipe – Design and Installation.

C. ASTM International:
   1. ASTM C1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.
   2. ASTM D2122 - Standard Test Method for Determining Dimensions of Thermo- plastic Pipe and Fittings.
   3. ASTM F1416 – Standard Practice for Installation Acceptance of Plastic Non-Pres- sure Sewer Lines Using Low-Pressure Air

D. Uni-Bell PVC Pipe Association:
   1. UNI-B-6-98 – Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Acceptance of any deviation from these testing requirements is at the sole discretion of the Engineer, Owners Representative, and Town of Kure Beach.

B. All defects in the pipelines, manholes and appurtenances shall be remedied by the Contractor at no additional expense to Engineer, Owner's Representative, or Town of Kure Beach and will be re-inspected as outlined in this Section.

1.4 SUBMITTALS

A. Section 01 33 00 – Submittal Procedures.

B. Submit following items prior to start of testing: 1. Testing procedures.
   2. List of test equipment.
   3. Testing sequence schedule.
   4. Provisions for disposal of flushing and test water. 5. Test gage calibration.
   6. Deflection mandrel drawings and calculations.

C. Test Results: Certified copies of test results shall be furnished to the Owner, Engineer, and Town of Kure Beach within 1 week.

D. CCTV Inspection: Submit two copies of the CCTV inspection to Engineer and Town of Kure Beach on hard drives. The digital media recordings, television inspection logs, and digital photographs shall be named and labeled to indicate the specific sewer segment, location, and contents.

PART 2 PRODUCTS

2.1 CCTV INSPECTION EQUIPMENT

A. The equipment used for the CCTV inspection shall be specifically designed and constructed for sanitary or pressure sewer inspection. Lighting for the camera shall be suitable to allow a clear picture of the entire periphery of the pipe. The camera shall be operative in 100% humidity conditions. The camera shall be a color, pan-and-tilt model. The camera shall be capable of being moved through the line in either direction at a uniform rate. A push camera system is acceptable for sewer laterals.

B. The camera, television monitor, and other components of the video system shall be capable of producing picture quality and resolution to the satisfaction of the Engineer.

C. Inspections shall be submitted to the Engineer or Owner in electronic (digital) NASSCO format that can be imported and exported with other NASSCO PACP certified software including POSM.

2.2 DEFLECTION TESTING OF PLASTIC SEWER PIPING

1. "Go/ No Go" mandrel. 2. Pull/retrieval ropes.

2.3 EXFILTRATION TESTING

A. Equipment:
1. Plug
s. 2. Pu
mp.
3. Measuring Device.

2.4 INFILTRATION TESTING

A. Equipment:
1. V-notch weirs.

2.5 LOW-PRESSURE AIR TESTING

A. Equipment:
1. Air compressor. 2. Air supply line.
3. Shutoff valves.
4. Pressure regulator.
5. Pressure relief valve. 6. Stopwatch.
7. Plugs.
8. Pressure Gage: Calibrate to 0.1 psi.
9. Clear tubing for water table measurement.

2.6 VACUUM TESTING

A. Equipment:
1. Vacuum pump.
2. Vacuum line.

3. Vacuum Tester Base:
    a. Compression band seal.
    b. Outlet port.
4. Shutoff Valve.
5. Stopwatch.
6. Plugs.
7. Vacuum Gage: Calibrated to 0.1 in. Hg.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 – Execution and Closeout Requirements.

B. Verify the following:
    1. Piping and manholes installation methods are compatible with testing requirements.
    2. Testing equipment is calibrated and functioning.
    3. Test procedures and recording methods have been submitted and approved.

3.2 PREPARATION

A. Section 01 70 00 – Execution and Closeout Requirements.

B. Plugs:
    1. Plug outlets, wye branches, and laterals.
    2. Brace plugs to resist test pressures.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 – Quality Requirements

B. Section 01 70 00 – Execution and Closeout Requirements.

C. CCTV Procedures:
    1. After the sewers are completely cleaned and water is introduced, the sewers shall be inspected by means of closed-circuit television to verify that the sewers have been thoroughly cleaned, to locate active sewer services and other connections, to document the condition, and to locate sewer defects.
    2. Existing flow in the sewer being inspected shall be temporarily bypassed in accordance with the Bypass Pumping Plan if satisfactory images cannot be obtained with flow on the sewer. Engineer, Owners Representative, or Town of Kure Beach will determine if the images are satisfactory.
    3. Provide ventilation and air movement to prevent the presence of vapor or mist in the sewer.
    4. CCTV inspections shall be performed in accordance with PACP© standards including the specific date and time of inspection.
    5. The camera shall be moved through the sewer by devices that do not obstruct the camera view, or interfere with proper documentation of the sewer conditions, such as manual or power winches, TV cable, and powered rewinds.

6. When manually operated winches are used to pull the television camera through the line, two-way radios, telephones, or other suitable means of communication shall be established between the two manholes or access points to ensure adequate communications between members of the crew.
7. The camera shall be moved through the line in either direction at a moderate rate, stopping to permit proper documentation of the condition. In no case shall the television camera be pulled at a speed greater than 30-feet per minute. The camera shall be stopped at joints, defects, points of significance, tributary connections, service laterals, and other connections and shall be panned, tilted, and rotated to fully view the defects and connections. Inspections shall be documented.
8. Perform dye testing during the CCTV inspections to locate and confirm active service laterals when directed to by Engineer or Town of Kure Beach.
9. Inspections shall be performed from manhole centerline to manhole centerline or access point to access point.
10. Record accurate measurements of distances. Accuracy of the distance meter shall be checked above grade by a suitable device. The accuracy shall be within 1 per- cent.

D. Deflection Testing of Plastic Sewer Piping:
1. Perform vertical ring deflection testing on PVC sewer piping after backfilling has been in place for at least 30 days.
2. Allowable maximum deflection for installed plastic sewer pipe is no greater than five percent of original vertical internal diameter.
3. Perform deflection testing using "go, no go" mandrel. 4. Mandrel Diameter:
   a. Not less than 95 percent of base or average ID of pipe.
   b. Pipe Diameter: Comply with ASTM D2122.
5. Perform testing without mechanical pulling devices.
6. Locate, excavate, replace, and retest piping that exceeds allowable deflection.

E. Exfiltration Testing of Pipes Larger Than 24 Inches in Diameter:
1. Perform exfiltration testing not exceeding 100 gal. for each inch of pipe diameter for each mile per day for each reach of piping undergoing testing.
2. Perform testing with minimum positive head of 2 feet.

F. Infiltration Testing:
1. Maximum Allowable Infiltration: 100 gallons per nominal inch diameter of pipe for each mile per day for the reach of piping undergoing testing.
2. Include allowances for leakage from manholes.

G. Low-Pressure Air Testing:
1. Testing shall be accomplished by plugging the line at each end with pneumatic plugs.
2. Test each reach of gravity sewer piping between manholes. 3. Low-pressure air test all connected service laterals.
4. Introduce air pressure slowly to approximately 4 psig.
5. Determine ground water elevation above spring line of piping.
6. For every foot of ground water above spring line of piping, increase starting air test pressure by 0.43 psi.
7. Do not increase pressure above 9 psig.

8. Allow pressure to stabilize for at least five minutes.
9. Adjust pressure to 3.5 psig or to increased test pressure as determined above when ground water is present.
10. Do not make allowance for laterals unless a test section having more than 625 square feet of lateral surface area fails to pass the air test. Adjust the time required according to UNI-B-6-98.
11. Minimum Testing Duration in Minutes:
    a. Shall be calculated by multiplying the nominal pipe size (inches) by 0.625.
12. Record drop in pressure during testing period.
13. If air pressure drops more than 1.0 psi during testing period, piping has failed.
14. If 1.0 psi air pressure drop has not occurred during testing period, piping is acceptable; discontinue testing.
15. If piping fails, test reach of piping in incremental stages until leaks are isolated, repair leaks, and retest entire reach between manholes.
16. If unsatisfactory testing results are achieved, make necessary repairs and retest until result meets criteria.
17. Repair visible leaks regardless of quantity of leakage.
18. UNI-B-6-98 TABLE I – MINIMUM SPECIFIED TIME REQUIRED FOR A 1.0 PSIG PRESSURE DROP FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q=0.0015

Min. Pipe Dia. (in.)	Time (min: sec)	Length For Min. Time (ft)	Time For Longer Length (sec)	Time (min:sec) for Length (L) Shown					
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft
4	3:46	597	.380 L	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	.854 L	5:40	5:40	5:40	5:40	5:40	5:40
8	7:34	298	1.520 L	7:34	7:34	7:34	7:34	7:36	8:52
10	9:26	239	2.374 L	9:26	9:26	9:26	9:53	11:52	13:51
12	11:20	199	3.418 L	11:20	11:20	11:24	14:15	17:05	19:56
15	14:10	159	5.342 L	14:10	14:10	17:48	22:15	26:42	31:09
18	17:00	133	7.692 L	17:00	19:13	25:38	32:03	38:27	44:52
21	19:50	114	10.470 L	19:50	26:10	34:54	43:37	52:21	61:00
24	22:40	99	13.674 L	22:47	34:11	45:34	56:58	68:22	79:46

H. Vacuum Testing:
1. Repair both outside and inside of joint to ensure permanent seal. 2. Test manholes prior to backfill.
3. Test manholes with manhole frame set in place. 4. Vacuum Testing:
    a. Comply with ASTM C1244.
    b. Plug pipe openings; securely brace plugs and pipe. c. Plug lift holes with non-shrink grout.
    d. Inflate compression band to create seal between vacuum base and structure.
    e. Connect vacuum pump to outlet port with valve open, then draw vacuum to 10 in. Hg (5 psig).
    f. Close valve.
    g. Manhole Test Duration in Seconds:
        1) Manhole Diameter of 4 Feet: 60.
        2) Manhole Diameter of 5 Feet: 75.

3) Manhole Diameter of 6 Feet: 90.

h. Record vacuum drop during test period.

i. If vacuum drop is greater than 1 in. Hg during testing period, repair and retest manhole.

j. If vacuum drop of 1.0 in. Hg does not occur during test period, manhole is acceptable; discontinue testing.

k. If vacuum test fails to meet 1.0-in. Hg drop in specified time after repair, repair and retest manhole.

5. If unsatisfactory testing results are achieved, repair manhole and retest until result meets criteria.

6. Repair visible leaks regardless of quantity of leakage.

END OF SECTION 331422

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SECTION 333111 – SANITARY SEWER GRAVITY MAINS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section gives the requirements for installation of gravity sewer pipe, service laterals and manholes. Service laterals shall be installed where shown on the approved drawings or as directed by Town of Kure Beach Engineering staff. Excavation, trenching and back filling is „covered in Section 02220: "Excavating, Grading, Trenching, and Backfilling".

B. The foreman of the contracting crew must speak fluent English.

1.02 SUBMITTALS

A. As-builts: Shall be submitted in accordance with Section 01720.

B. Shop Drawings: Contractor shall furnish to Engineer and Town of Kure Beach Engineering shop drawings and material specification sheets of all material and items to be installed or delivered as specified in Section 01340: Submittals.

1.03 REFERENCES

A. ASTM D1784 - Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

B. ASTM D1785 - Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

C. ASTM D2241 - Poly (Vinyl Chloride) (PVC) Pressure-rated pipe (SDRSERIES).

D. ASTM D2152 - Test Method for Degree of Fusion of Extruded Poly (Vinyl Chloride) (PVC) Pipe and Molded Fittings by Acetone Immersion.

E. ASTM D2321 - Underground Installation of Flexible Thermoplastic Sewer Pipe.

F. ASTM D2412 - External Loading Properties of Plastic Pipe by Parallel-Plate Loading.

G. ASTM D2444 - Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight).

H. ASTM D3034 - Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

I. ASTM D-3212 - Elastomeric push-on joints for plastic pipe.

J. AWWA C600 - Installation of Ductile - Iron water mains and appurtenances.

K. AWWA C900 - PVC Pressure Pipe 4 inch through 12 inch.

L. AWWA C905 - PVC Pressure Pipe 14 inch through 36 inch.

M. ASTM D2672 - Bell-End Poly (Vinyl Chloride) (PVC) Pipe.

N. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

O. ASTM F478 - Precast Concrete Manhole Risers and Tops.

P. ASTM C497 - Concrete Pipe, Manhole Sections, or Tile

Q. ASTM F679 - Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings

R. ASTM A746 - Ductile Iron Gravity Sewer Pipe

S. ASTM F794 - Poly (Vinyl Chloride) (PVC) Ribbed Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.

PART 2 PRODUCTS

2.01 POLYVINYL CHLORIDE (PVC) PIPE

A. Sewer mains with depth of earth cover greater than 3 feet.

1. For pipe sizes 4" through 12", pipe shall be Class 150, DR18 conforming to the requirements of AWWA C900 with elastomeric push-on joints conforming to ASTM D3212 or ASTM D3139.
2. For pipe sizes 14" through 24", pipe shall be Class 235, DR18 conforming to the requirements of AWWA C905 with elastomeric push-on joints conforming to ASTM D3212 or ASTM D3139.
3. For pipe sizes larger than 24" pipe shall be closed profile conforming to the requirements of ASTM F794 with a minimum pipe stiffness of 46 PSI and with elastomeric push-on joints conforming to ASTM D 3212 or ASTM D3139.

B. Couplings shall be mechanical joint ductile iron.

C. Pipe and fittings used for sewer service laterals shall be 4" or 6" schedule 40 conforming to ASTM D1785 with solvent welded joints.

D. Fasteners shall be 316 stainless steel or better where exposed to sewer or sewer gases.

2.02 DUCTILE IRON PIPE

Ductile Iron Pipe: Conforming to ASTM A746, ANSI/AWWA CI51/A21.51, Class 350, lined with Protecto 401 ceramic epoxy, "Sewpercoat" or approved equal unless otherwise shown or specified.

A. Joints shall be rubber gasket push-on, conforming to ANSI/AWWA C111/A21.11, or mechanical joint conforming to ANSI/AWWA C110/A21.10, as modified by ANSI/AWWA C151/A21.51.

B. Fittings and specials shall be suitable for 150 pounds per square inch pressure rating, unless otherwise specified. Fittings and specials for mechanical joint pipe shall conform to ANSI/AWWA C110/A21.10. Fittings and specials for use with push-on joint pipe shall conform to ANSI/AWWA C111/A21.11 lined with protecto 401 ceramic epoxy, "Sewpercoat" or approved equal unless otherwise shown or specified.

2.03 PIPE COUPLINGS

Couplings between dissimilar pipe materials (PVC to ductile iron) shall be mechanical joint ductile iron only or adapter conforming to ASTM 3139 lined with Protecto 401 ceramic epoxy, "Sewpercoat" or approved equal unless otherwise shown or specified. For pipes 8" and larger, manholes are also acceptable. Fernco couplings are NOT permitted.

2.04 MANHOLES

A. Manholes shall be precast concrete only conforming to ASTM C478.

1. Joint surfaces between bases, risers and cones shall be manufactured to the joint surface design and tolerance requirements of ASTM C76.

2. Flexible joint sealants shall be butyl rubber based conforming to Federal Specification SS-S-210A, AASHTO M-198, Type B - Butyl Rubber and as follows: maximum of 1% volatile matter and suitable for application temperatures between 10 and 100 degrees F.

3. Joints between precast components shall be sealed between the tongue and the groove and additionally around the internal and external perimeter as follows:

   a. Tongue and groove seals shall consist of a plastic or paper-backed butyl rubber rope no less than 14 feet long and having a cross-sectional area no less than the annular space times the height of the joint.

   b. Internal seals shall consist of Type S mortar grout.

   c. External seals shall consist of Type S mortar grout or plastic or paper-backed butyl rubber rope no less than 14 feet long and having a cross-sectional area no less than the annular space times the height of the joint.

4. Pipe to manhole connectors shall conform to ASTM C923. The location of the pipe connectors shall vary from the location shown on the project plans no more than ½ inch vertically and 5 degrees horizontally. Provide for control of the pipe OD to within the tolerances of the connector on flexible pipes larger than 12 inches.

5. Concrete shall conform to ASTM C478 and as follows:

   a. Compressive strength: 4000 psi minimum at 28 days.

   b. Air Content: 4 percent minimum.

   c. Cementitious Materials: Minimum of 564 pounds per c.y.

   d. Coarse Aggregates: ASTM C33.

   e. Fine Aggregates: ASTM C33. Free from organic impurities.

   f. Chemical Admixtures: ASTM C494. Calcium Chloride or admixtures containing calcium shall not be used.

   g. Air Entraining Admixtures: ASTM C260.

6. Mortar: ASTM C270, Type S.

7. Grout: Grout for sealing openings and joints in manholes shall be Type S mortar. No Preco or Hydraulic Cement shall be permitted.

8. Brick: Brick shall be used to bring manhole rings to grade or filler for forming manhole inverts only and shall conform to ASTM C62 Grade SW or ASTM C32 Grade MS.

9. Manholes 4' deep or less shall have an eccentric cone or a flat top.

10. Manholes over 4 feet deep shall have an eccentric cone.

11. Manholes shall have a minimum inside diameter of 4 feet for sewer mains 18 inches diameter and smaller shall be 5 feet inside diameter for sewer mains larger than 18 inches. Larger inside diameters may be required for larger pipe sizes, more than two pipes, or when entrance/exit angle requires.

12. Drop manholes shall be inside drop with a minimum inside diameter of 5 feet.

13. 5 foot diameter manholes shall have a 8 inch extended base. For 4 foot diameter manholes shall have a 6 inch extended base. All extended bases shall have a minimum thickness of 6-inches.

14. Manhole steps shall be provided in bases, risers, cones, transition cones and transition top sections aligned vertically on 16" centers. Steps shall be secured to the wall with a compression fit in tapered holes or cast in place. Steps shall not be vibrated or driven into freshly cast concrete or grouted in place. The steps shall be Copolymer Polypropylene Plastic reinforced with a ½" diameter grade 60 bar and have serrated tread and tall end lugs. Step pullout strength

shall be tested according to ASTM C497.

15. Sewer Guard Manhole Inserts: Each manhole shall be equipped with an insert of high density copolymer meeting the requirements of ASTM 124 with gas and vacuum relief valves matching manhole covers and rings. The insert shall be similar or equal to Sewer Guards manufactured by Southwestern Packing and Seals. Manholes located in traffic areas shall have stainless steel sewer guards by Southwestern Packing and Seals or approved equal.

16. Manhole interiors that are required to be lined shall be coated with Zebron 386, Duramar 1030 as manufactured by Sewerkote, or equal as approved by Engineer and Town of Kure Beach Engineering staff. Coal tar epoxy linings and Raven Lining Systems are not acceptable if field applied.

17. All in place penetrations into manholes must be by core boring methods including main line and service drops. Properly sized elastomeric boots shall be set in penetrations. The boot and the pipe must be fully mortared on the inside and the outside of the manhole.

18. Inside drop for sewer mains and services shall conform to the detail with all material to be 316 stainless steel or better, excluding piping. Drop pipe shall be anchored to the manhole as shown on the detail with intermediate supports on 30-inch spacing as required.

19. Vents shall be constructed of aluminum or type 316 steel or better and shall extend a minimum of 2 foot above 100-year flood and equipped with a non-corrosive bug screen. The maximum spacing is 1,000 feet separation between vented manholes.

B. Grey Iron Castings:

1. Manhole Castings: All iron casting for manhole frames and covers, inlet frame and traps and other sewer appurtenances, unless other specified, shall conform to ASTM A48 "Grey Iron Castings: Class 30B" and shall be marked "Sanitary Sewers". Standard and watertight frames shall have a 24 inch clear opening. Standard covers shall have up to four 1" diameter vent holes. All covers shall have lifting bars in lieu of pickholes. Watertight covers are required on all manholes where the rim elevation is less than 1 foot above the 100-year flood. All manhole castings shall be American made or machined to insure proper fit. Any manhole shall be rejected if, in the sole opinion of the Engineer or Town of Kure Beach Engineering staff, the frame and cover or installation is unacceptable.

   A. Standard frames and vented cover, manufacturer and style to be approved by a submittal to Engineer and Town of Kure Beach Engineering staff. The following are approved for use on Town of Kure Beach systems:

      1. U.S. Foundry 725 ring and LJ cover
      2. East Jordan Iron Works 7 ½" Frame (in traffic areas) Product #202711, 4" Frame Product #202611 - Cover Product #202746
      3. U.S. Foundry 710 ring and LJ cover (in traffic areas)
      4. Capitol Foundry of Virginia, Item MH-3000 ring & cover.
      5. General Foundries, Inc., Item GFI-7126, frame & cover (in traffic areas).
      6. General Foundries, Inc., Item GFI-4126, frame & cover.

   B. Watertight frames and non-vented cover, manufacturer and style to be approved by submittal by Engineer and the Town of Kure Beach Engineering staff. The following are approved for use on Town of Kure Beach systems:

1. U.S. Foundry 725 ring and LJ-SSG cover
2. East Jordan Iron Works 7 ½" Frame and Cover Assembly (in traffic areas) Product #202701, 4" Frame Product #202611 - Cover Product #202722
3. U.S. Foundry 710 ring and LJ-SSG cover (in traffic areas)
4. Capital Foundry of Virginia, Item MH-3000-WT ring & cover.

2. Cleanouts: A nominal 6" diameter by 12" cast-iron box and cover shall be furnished and installed flush with the final grade as per standard detail. "C.O." shall be stamped on lid. The box shall conform to the standard detail.
3. Adjusting Rings:
   A. Concrete adjusting rings shall be pre-cast and conform to ASTM C478.

PART 3 EXECUTION

3.01 PIPE INSTALLATION

A. Install PVC pipe in strict accordance with ASTM D2321. Install manholes as indicated on the plans. Install Ductile Iron Pipe in accordance with AWWA C600. Excavation and backfill shall be accomplished as specified under Section 02220 - "Excavating, Grading, Trenching & Backfilling".

B. Pipe shall be kept clean at all times, and no pipe shall be used in the work that does not conform to the appropriate ASTM Specifications. The laying of pipe in finished trenches shall commence at the lowest point, with the spigot ends pointing in the direction of the flow. All pipe shall be laid with the ends abutting accurately to the lines and grades as shown on the plans, or as directed by the Owner. They shall be carefully centered so that when laid they will form a sewer with uniform invert.

Preparatory to making pipe joints, all surfaces of the portion of the pipe to be jointed or of the factory made jointing material shall be clean and dry. Lubricants, primer, adhesives, etc., shall be used as recommended by the pipe or joint manufacturer's specifications. The jointing material or factory fabricated joints shall then be placed, fitted, and adjusted in such workmanlike manner as to obtain the degrees of water tightness required. Trenches shall be kept dry during bedding, laying and jointing and for as long a period as required. As soon as possible after the joint is made, sufficient backfill material shall be placed along each side of the pipe to offset conditions that might tend to move the pipe off line and grade.

Where more than one pipe line is laid in the same trench and the invert elevations are not identical, and where no concrete cradle or encasement is provided for the support of the higher pipe line, its foundation shall be considered to be yielding. When bridging is required to support a portion of the pipeline over such yielding trench bottom, the pipe line itself shall not be considered to provide bridging strength, and supplementary materials for this purpose shall be provided.

C. No superficial loads shall be placed on the exposed surface of the trench, unless the backfill is of non-cohesive material, is vibrated or is tamped in layers not exceeding 6-inches in depth, until the Owner is satisfied that sufficient settlement has occurred to alleviate undue live or impact loads. Any defects due to settlement shall be corrected by the Contractor. Bell holes shall be dug sufficiently large to insure the making of proper joints. Water shall not be allowed to rise in the excavation until the joint material has received its set. Great care shall be used to secure water tightness, and to prevent damage to or disturbing of the joints during the backfilling process, or at any other time. Special precautions shall be exercised to prevent any pipe from resting on rock or any other hard projection which might cause breakage of pipe. During construction, the mouth of the completed pipe shall always be kept properly closed with a suitable plug to prevent the entrance therein of any water, earth, stones or other

debris. The Contractor shall also take any and all measures to keep the pipe clean and free from deposits and protect the pipe from damage.

D. Cleaning Pipe: The pipes shall be thoroughly cleaned before they are laid and shall be kept clean until acceptance of the completed work. The upper end of all pipe lines shall be provided with a header carefully fitted, so as to keep dirt and other substances from entering. This header shall be kept in the end of the pipe line at all times when laying is not in actual progress.

E. Shoring, Sheeting and Well-Pointing: The Contractor shall include in his price bid for pipe the placing of all necessary shoring, sheeting and well-pointing, gravel bedding, and any other dewatering devices to prevent damage to other installations and where required by the Owner.

F. Service Connecting: Sewer laterals shall be connected to the main by means of a wye fitting installed in the top quadrant of the pipe but shall not be installed straight up. Where it is necessary to lay new house services or relay or tie in existing house services, the Contractor shall use the materials and type joints as set forth on the plans, as given in the specifications, or as directed by the Engineer. These services shall be sized as designated on the plans or as shown on details. The service connection shall be located such that a minimum clearance of 25 feet is provided between potable water wells and sanitary sewer lines.

Service piping shall be perpendicular with the main unless otherwise approved by the Engineer. Where new mains are being laid, the house service shall be connected to the main by means of a wye set in the main with the branch turned up in such manner that a good square connection will be made with the grade of the house service. Service pipe shall connect to the main at manholes when noted on the drawings or when requested by the Engineer by core boring the manhole and field installation of the proper size elastomeric boot mortared inside and outside of the manhole. Service lines that enter manholes shall enter on the shelf or at a minimum of crown to crown for the receiving pipe. Service lines shall be terminated at property line or edge of easement as shown on Standard Detail.

All house connections shall be laid to a point from the property line as shown in details. Contractor shall provide a clean-out and stub solvent weld cap as shown in details. During installation, any services or utilities damaged by the Contractor shall be properly maintained and repaired by the Contractor at his expense.

All house laterals installed under paved streets shall be installed by the compacted bore method. Where conditions prohibit the use of the compacted bore method, alternate methods may be used as approved by the Engineer.

G. Clean-outs: Clean-outs shall be located as per standard detail, and at a minimum of 12 feet from all property corners. A 6 inch diameter cast-iron box and cover shall be provided over clean-out plug. The cast iron box shall be marked by a landscape timber 2 feet in the ground and 2 feet exposed above ground.

H. Pavement Replacements: Where it is necessary for the Contractor to cut, drop, or otherwise remove pavement to install sewer lines, the Contractor shall replace all pavement in accordance with the Section 02513: "Asphalt Concrete Paving" of these specifications.

I. Salvage: All salvage materials of whatever nature shall be disposed of at the direction of the Engineer. Particularly care must be exercised in handling salvaged materials by the contractor.

3.02 MANHOLE INSTALLATION

A. General: Manholes shall be constructed of pre-cast concrete rings in accordance with

the Drawings. The pre-cast concrete base shall be placed on a six inch (minimum) stone bedding foundation which shall extend up around the pipes to at least 3 inches above the top line of the pipes. The stone bedding shall be considered as incidental to the unit price bid for the installed manhole. Pipes entering the pre-cast sections of the manhole shall be inserted into the adaptor couplings provided. All pre-cast manhole components shall be lifted and moved by use of suitable lifting slings and plugs that will not damage the pre-cast manhole lip.

All damage to pre-cast sections shall be thoroughly repaired in the presence of the Engineer. Repair and patching of minor breaks shall be done by chipping and scarifying the defective area before application of grout. Pre-cast sections shall be subject to rejection on account of failure to conform to any of the specification requirements. In addition, individual sections of manhole sections may be rejected because of fractures or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint; defects that indicate imperfect proportioning, mixing, and molding; surface defects indicating honey- combed or open texture; damaged or cracked end, where such damage would prevent making a satisfactory joint; and/or any continuous crack having a surface which width of 0.01 inches or more and extending for a length of 12 inches or more, regardless of position in the section wall.

B. The Contractor is responsible for getting the manhole tops to proper grade. Profiles on the plans are for cost estimates only. The top of the pre-cast manhole may be brought to proper grade for receiving manhole frames by using brick with a maximum adjustment of 12 inches from pre-cast cone to the cast iron ring. Masonry construction shall be preformed by experienced and qualified workmen. All work shall be laid plumb, straight, level, square, and true. The Contractor shall set and bond the manhole frame in a full bed of mortar. All manhole steps and miscellaneous items shall be properly bedded. The masonry walls shall be parged on the inside and outside with a ½-inch coat of Type S mortar.

Wedging or the placing of the shims to secure proper level will not be used in setting of manhole sections. Manholes located in unpaved roads shall be constructed with top of lid located 8 inches below road surface and a concrete reference marker shall be placed at the adjacent right of way line.

C. Invert Channels: The invert channels shall be 3/4 the depth of the largest pipe and shall be smooth and semicircular in shape conforming to the inside of the adjacent sewer section. Changes in direction of flow shall be made with a smooth curve of as large a radius as the size of the manhole will permit. Changes in size and grade of channels shall be made gradually and evenly. The invert channels shall be formed directly in the concrete of the manhole base or shall be built up with solid brick and Type S mortar.

All upstream pipes (including services) shall have sloped invert channel slides that provide smooth transitions to the downstream invert channel. Invert channel slides shall be the diameter of the entering pipe and be formed as a channel that is at least 3/4 pipe deep. Upstream pipes that enter at the shelf shall have their invert channel slides smoothly cast into the shelf with a sloping transition to the downstream pipe invert.

The floor of the manhole outside the channels, or slides, shall be smooth and shall slope toward the channels not less than 1 inch per foot nor more than 2 inches per foot. No laser bowl invert manholes shall be permitted.

D. Grade Rings: Manhole castings shall be installed to grade using 24 inch inside diameter pre-cast concrete grade rings, or brick grouted in place, for a maximum adjustment of 12 inches. Manhole sections shall be used for greater adjustment, unless approved otherwise. Flat top manholes shall not be adjusted by more than one

course of brick.

E. Drop Manholes: Inside drop only with minimum 5' diameter. Where sewer lines enter on a grade 30 inches or more above the invert of the discharge line, a drop manhole shall be constructed as directed by the Engineer. The drop or drops, shall be constructed in accordance with the Standard Detail, as shown on the plans, of 316 stainless steel or better excluding pipe with intermediate supports on 30-inch spacing as required.

3.03 CUTTING OF PIPE

Cut pipe in a neat manner without damage to the pipe or any fittings or specials.

3.04 ADJACENT FACILITIES

A. Water Mains

1. Horizontal and Vertical Separation

A. Minimum horizontal separation between gravity sanitary sewer lines and existing or proposed water mains (measured edge of pipe to edge of pipe) shall be 10 feet for PVC pipe. Any deviation from the minimum separation shall involve the water main in a separate trench or on an undisturbed earth shelf located on one side of the sewer at an elevation so the bottom of the water main is at least 18 inches above the top of sewer.

B. If it is impossible to obtain proper horizontal and vertical separation as described above or anytime sewer must be laid above a water main, both the water main and sewer main must be constructed of class 350 ductile iron pipe and prepared for pressure testing to 150 psi to assure water-tightness before backfilling.

2. Crossings

A. Sewers crossing water mains shall be laid to provide a minimum vertical separation of 18 inches between the bottom of the water main pipe and the top of the sewer pipe. The crossing shall be arranged perpendicularly so that the sewer joints will be equidistant and at least 10 feet from the crossing in each direction.

B. When it is impossible to obtain proper horizontal and vertical separation as stipulated above, one of the following methods must be specified:

i. The sewer shall be designed and constructed of class 350 ductile iron pipe and prepared for pressure testing to 150 psi to assure water-tightness prior to backfilling, or

ii. Either the water main or the sewer line may be encased in a watertight carrier pipe which extends 10 feet on both sides of the crossing, measured perpendicular to the water main. The carrier pipe shall be of materials approved by the Engineer or Town of Kure Beach Engineering staff for use in water main construction. All joints of pipe inside carrier pipe shall be class 350 ductile iron with mega-lug mechanical joints throughout.

B. Wells

1. No manhole shall be placed within 100 feet of a well utilized for potable water.
2. No sewer piping shall be placed within 25 feet of a well utilized for potable water.
3. Minimum specifications for sewer piping placed between 25 feet and 50 feet of a well utilized for potable water shall meet or exceed the requirements Class 350, ductile iron with push on joints conforming to ANSI A21.50/A21.51 lined with Protecto 401 ceramic epoxy or approved equal.

C. Storm Drains: Provide 24 inches of soil between sewer lines and storm drains. When a 24 inch minimum separation cannot be achieved, use ductile iron pipe and/or structural bridging to provide the required support. The ductile iron pipe shall extend a minimum distance of 10 feet centered at the storm drain. Where sanitary sewer is installed under existing storm drain structures or pipe, flowable fill as approved by Town of Kure Beach Engineering staff and N.C. Department of Transportation (where applicable), must be used where proper compaction cannot be obtained.

D. Roads and Ditches: Provide 36 inch minimum cover for PVC beneath the roads and ditches. When a roadside ditch is perpendicular to the sewer service, a minimum cover of 24 inch will be allowed. Otherwise construct the sewer of ductile iron pipe or encase the pipe in concrete.

3.05 MINIMUM GRADE (Unless otherwise directed or shown on the plans)

3.05.1.1.1.1 4 INCH PIPE: One foot per 100 feet (1.0 percent).

3.05.1.1.1.2 6 INCH PIPE: 0.6 feet per 100 feet (0.6 percent).

3.05.1.1.1.3 8 INCH PIPE: 0.4 feet per 100 feet (0.4 percent).

3.05.1.1.1.4 10 INCH PIPE: 0.28 feet per 100 feet (0.28 percent).

3.05.1.1.1.5 12 INCH PIPE: 0.22 feet per 100 feet (0.22 percent)

3.06 BACKFILL

Materials and installation of pipe bedding haunching and backfill shall be in accordance with Section 02220, "Excavating, Grading, Trenching and Backfilling".

3.07 SERVICE CONNECTIONS

Service Connection: Install at locations shown on the drawings, or as designated by the Owner's representative. Service connections shall consist of wye branch, fittings, cleanout, cast iron box and cover, and pipe, as detailed on the drawings. Set cleanout box on 4 inches of stone.

3.08 FIELD QUALITY CONTROL

Field inspection, sampling and testing will be performed per Owner's instructions.

3.09 SALVAGE

All salvage materials of whatever nature shall be disposed of at the direction of the Engineer. Particularly care must be exercised in handling salvaged materials by the Contractor.

3.10 TESTING

A. General: The Contractor shall be responsible for providing all equipment necessary for tests of displacement, deflection, and leakage. Tests for deflection and leakage shall be performed by the Contractor and observed by Engineer or Town of Kure Beach Engineering Staff. Each segment of line shall be tested:

1. 30 days prior to final acceptance of the project if required and in any event, all segments of main and all services shall be cameraed in the presence of the Authority's representative at no cost to the Authority.
2. After two (2) paper copies of the as-builts have been submitted to Town of Kure Beach.
3. After gravel has been installed on all roadways.
4. After forty-eight (48) hour notice is given to Town of Kure Beach Engineering staff.

The camera inspection must be performed upon completing of cleaning and potable water introduced into the system to be tested. All defects in the pipeline and appurtenances shall be remedied by the Contractor at no additional expense to the Engineer, Owners Representative, or Town of Kure Beach and will be reinspected as outlined above. Acceptance of any deviation from these requirements is at the sole discretion of the Authority.

B. Test for Deflection: Deflection tests may be performed on all sections of flexible pipe.
1. Maximum allowable deflection shall be 5 percent at any point.
2. Deflection shall be measured with a pin-type mandrel "Go/No Go" gauge. The gauge shall be pulled through the pipe by means of a strong cord or cable.
3. Any section of pipe not meeting the 5 percent maximum deflective requirement shall be excavated, backfilled, re-compacted and retested.

C. Test for Leakage: All segments of completed line may be tested for leakage by low pressure air test, except that the infiltration test may be used as approved by the Owner's representative. The Authority may choose to camera the pipe. Acceptance of any deviation from these requirements is at the sole discretion of the Town of Kure Beach.
1. The Contractor shall remedy all visible leaks in pipes, manholes, and appurtenances.
2. Maximum allowable leakage for the system shall be 0 gallons per inch pipe diameter per linear mile of pipe per 24 hours, including manhole infiltration. No single segment of line (manhole to manhole) shall exceed this requirement.
3. Air Testing: Air testing shall be required if, in the sole opinion of the Town of Kure Beach, conditions are such that infiltration measurements may be inconclusive. The test shall be conducted in the presence of the Engineer or Town of Kure Beach Engineer and shall conform to the following requirements:
   a. Test pressure shall be 3.5 psi increased by the ground water pressure above the top of the sewer.
   b. Pressure loss from 3.5 psi shall not exceed 0.5 psi during the required testing time.
   c. Testing time in minutes shall be calculated as 0.625 x nominal pipe size (inches).

D. Testing Manholes:
1. Each manhole may be tested immediately after assembly and prior to backfilling.
2. All lift holes shall be plugged with an approved Type "S" grout.
3. All pipes entering the manhole shall be plugged, taking care to securely brace the plug from being drawn into the manhole. Unless plugs are mechanically restrained, it is recommended that the plugs are used with a minimum of 2 times safety factor above the test pressure.
4. The test head shall be placed at the inside of the top of the cone section and the seal inflated in accordance with the manufacturers' recommendations.

5. A vacuum of 10 inches (5 psig) of mercury shall be drawn and the vacuum pump shut off. With the valves closed, the time shall be measured for the vacuum to drop to 9 inches. The manhole shall pass if the time is greater than 60 seconds for 48 inch diameter, 75 seconds for 60 inch.

6. If the manhole fails the initial test, necessary repairs shall be made with a non-shrink grout while the vacuum is still being drawn. You shall retest until a satisfactory test is obtained.

7. After the gravity sewers and manholes have been installed and backfilled, the manholes shall be inspected for leakage. No visible leaks will be permitted.

E. Test Results: Certified copies of all test results shall be furnished to the Owner, Engineer, and the Town of Kure Beach Engineering staff within 1 week after the test.

PART 4 PAYMENT

4.01 PAYMENT

Payment for this section shall be made based on the actual measurement of work at the unit price shown in the contract proposal form. C900/905 unit pipe prices to include all cost associated with installation such as all fittings, adaptors, and specials installed complete in place.

END OF SECTION 333111

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SECTION 333123 – SANITARY SEWER FORCEMAIN, VALVES & APPURTENANCES

PART 1 GENERAL

1.01 WORK INCLUDED

A. This section covers the installation of wastewater force mains, including pipe, valves and service connections. Excavation, trenching and backfilling is covered in Section 02220: "Excavating, Grading, Trenching, & Backfilling".

B. The foreman of the contracting crew must speak fluent English.

1.02 RELATED WORK

A. Section 02220: "Excavating, Grading, Trenching, & Backfilling"

B. Section 02733: "Wastewater Pumping Station"

C. Section 02731: "Gravity Sanitary Sewer System"

1.03 GENERAL

A. Piping for wastewater force mains: 2-inch force mains shall be SDR21 Gasketted PVC. Force mains larger than 2-inch shall be DR 18 PVC. Other piping material only allowed as approved by Engineer or Town of Kure Beach Engineering staff.

1.04 REFERENCES

A. ASTM D2241 - Poly (Vinyl Chloride) (PVC) plastic pipe (SDR-PR).

B. ASTM D3139 - Joints for plastic pipe using elastomeric seals.

C. ASTM F477 - Elastomeric seals for jointing plastic pipe.

D. ASTM D1785 - Poly (Vinyl Chloride) (PVC) plastic pipe, schedules 40, 80 and 120.

E. ASTM D2467 - Socket - Type Poly (Vinyl Chloride) (PVC) plastic pipe fittings, schedule 80.

PRODUCTS

2.01 Wastewater Force Mains

A. Pipe shall conform to requirements of Class 150 (DR18) C900 or class 235 (DR18) C905. Joints shall conform to ASTM D3139 and Gaskets to ASTM F477.

B. Mechanical Joint: Suitable for 150 pounds per square inch minimum pressure rating. Fittings and specials shall conform to ANSI/AWWA C153/A21.53.

C. Ductile iron pipe shall conform to ANSI/AWWA C150/A21.50, ANSI/AWWA C151/A21.51, Class 350 shall be lined with ceramic epoxy lining Protecto 401 or equal.

2.02 GATE VALVES

A. Iron body, bronze mounted, double disc, parallel seat type meeting the full requirements of AWWA C500, or resilient seated in conformance with AWWA C509 or C515, with a minimum working pressure of 150 pounds per square inch. Valves shall have 2 inch operating nut and open left, and shall have 0-ring seals. Valve ends shall be mechanical joint, unless otherwise shown or specified. Valves shall be manufactured by Mueller.

American Darling or Clow Corporation or approved equal. Direct bury of plug valves is

not allowed.

2.03 VALVE BOXES AND COLLARS

A. Valve Boxes shall be cast iron screw-type adjustment type with flared base. The word "SEWER" shall be cast in the cover. The boxes shall be of such length as will be adapted, without full extension, to the depth of cover required over the pipe at the valve location. Boxes shall be installed over each valve, unless otherwise shown or specified. Valve boxes shall conform to ASTM A48" grey iron castings, class 303.

B. Valve box concrete collars: Valve boxes in unpaved areas shall be installed with pre-cast concrete collars.

2.04 PIPE MARKING TAPE

A. Tape shall be 3 inches wide, green in color, bearing continuous message "CAUTION SEWER LINE BURIED BELOW." Tape shall be made of plastic or other permanent material with metalized foil core and shall be installed 18" above the installed line.

B. A 10 gauge insulated copper wire shall be run continuously along the pipe and shall be securely taped to the water line. All splices in the wire shall be made by use of an underground rated, watertight, and approved splice connector. No twisting of wire ends is permitted. The locator wire shall not be wrapped around the pipe, flanges, bells, valves, or other appurtenances. The locator wire shall be accessible above ground at one thousand feet (1,000') intervals and shall be protected by a cast iron box with cover marked "sewer" with a concrete collar. At valve boxes, the wire shall be brought up on the outside of the box and folded under lid.

2.05 SEWAGE AIR AND VACUUM VALVES

A. Air and Vacuum Valve: The air and vacuum valve shall allow unrestricted venting or re- entry of air during filling or draining of force main. Valve shall incorporate two (2) stainless steel floats with stainless steel connecting float guide. All internals shall be removable through top cover. Valves shall be supplied with inlet and blow-off valves and quick disconnect with 5' of hose. The valve shall satisfactorily withstand hydrostatic pressures of 300 psi. Valves shall be manufactured for use in sanitary sewer. The valve shall be constructed of cast iron body and top flange with stainless steel float and shall be 2" NPT screwed inlet and 1" NPT outlet. Valves shall be APCO Valve Series 401 SAVV or approved equal. Valves shall be mounted on McDonald 3800 series saddle with 316 G stainless steel or better valve and nipples.

B. Air release valves shall be installed where the distance between the low point and high point in the force main exceeds 10 vertical feet.

C. Air and Vacuum Valve Manhole: Ring, cover and 5' diameter precast manhole shall conform to the plans and with Section 02731 of these specifications.

2.06 MECHANICAL JOINT RESTRAINT GLAND

A. Mechanical joint restraint shall be incorporated in the design of the follower gland and shall include a restraining mechanism which, when actuated, imparts multiple wedging action against the pipe, increasing its resistance as the pressure increases. Flexibility of the joint shall be maintained after burial.

B. Glands shall be manufactured of ductile iron conforming to ASTM A536-80. Restraining devices shall be of ductile iron heat treated to a minimum hardness of 370 BHN. Dimensions of the gland shall be such that it can be used with the standardized mechanical joint bell and tee-head bolts conforming to ANSI/AWWA A21.11 and ANSI/AWWA C153/A21.53 of latest revision. Twist-off nuts shall be used to insure proper actuating of the restraining devices.

C. The Mechanical joint restraint device shall have a working pressure of at least 250 psi with a minimum safety factor of 2:1.

D. Restraint glands shall be "Megalug" as manufactured by EBAA Iron, Inc.

2.07 FITTINGS & SPECIALS: Fittings and specials shall be class 54 ductile iron, mechanical joint in accordance with ANSI/AWWA C111/A21.11, ANSI/AWWA CI53/A21.53, 150 pounds per square inch pressure rating unless otherwise shown or specified, except that profile of bell may have special dimensions as required by the pipe manufacturer with elastomeric gaskets. Ductile iron fittings and specials shall be lined with ceramic epoxy protecto 401 or equal.

PART 3 EXECUTION

3.01 GENERAL

A. Install PVC and ductile iron pipe in strict conformance with AWWA C600 and the recommendations of AWWA Manual of Practice M23. Minimum depth of bury above the top of pipe shall be 36 inches.

3.02 CUTTING OF PIPE

A. Cut pipe in a neat manner without damage to the pipe or its lining.

3.03 ADJACENT FACILITIES

A. Sewer Lines: Where the location of the sewer pipe is not clearly defined in dimensions on the drawings, the sewer pipe shall not be laid closer horizontally than 10 feet from a water line except where the bottom of the water pipe will be at least 18 inches above the top of the sewer pipe. Where water lines are less than 18 inches above the sewer lines, or cross under sewer lines (must be approved on a case by case basis), the sewer pipe and water pipe for a distance of at least 10 feet each side of the crossing shall be made of ductile iron pressure pipe with no joint located within 8 feet horizontally of the crossing.

B. Force mains shall not be laid in the same trench with water lines, gas lines or electric wiring.

C. Wells

1. No force main shall be placed within 25 feet of a well utilized for potable water.
2. Minimum specifications for force mains placed between 25 feet and 50 feet of a well utilized for potable water shall meet or exceed the requirements Class 50, ductile iron with push on joints conforming to ANSI A21.50/A21.51 lined with Protecto 401 ceramic epoxy or approved equal.

3.04 PIPE DEFLECTION

A. Maximum pipe deflection shall not exceed manufacturer's recommendations.

3.05 JOINTING

A. PVC Pipe: Install in accordance with AWWA Manual of Practice M23, modified as necessary by the recommendations of the manufacturer.

B. Connections between different types of pipe and accessories shall be made with transition fittings approved by the Engineer or Town of Kure Beach Engineering staff.

3.06 SETTING OF VALVES AND VALVE BOXES

A. Valves and Valve Boxes: Install where shown or directed and set plumb. Valve boxes shall be centered on the valves. Boxes shall be installed over each outside gate valve. Where feasible, valves shall be located outside the area of roads and streets. Earth fill shall be carefully tamped around each valve box to a distance of 4 feet on all sides of

the box, or to the undisturbed trench face if less than 4 feet. Valve cover shall be cast with "SEWER" on top. A concrete collar must be installed with all valve boxes in unpaved areas.

B. Valves after delivery shall be drained to prevent freezing and shall have the interiors cleaned of all foreign matter before installation. Stuffing boxes shall be tightened and the valve shall be fully opened and fully closed to insure that all parts are in working condition.

3.07 RESTRAINING/BLOCKING: The plugs, caps, tees and bends deflecting 22-1/2 degrees or more either vertically or horizontally on force mains 4-inches in diameter or larger shall be provided with thrust blocking or "Megalug" retainer gland at each joint installed per manufacturer's requirements. Blocking shall be placed between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, the base and thrust bearing sides of the thrust blocks shall be poured directly against undisturbed earth. The sides of thrust blocks not subject to thrust may be poured against forms. The area of bearing shall be as shown on the plans or as directed. Blocking shall be placed so that the fitting joints will be accessible for repair. Steel rods and clamps shall be type 316 stainless steel or better.

3.08 HYDROSTATIC TESTS

A. General: Where any section of a sewer line is provided with concrete thrust blocking the hydrostatic test shall not be made until at least 5 days after installation of the concrete thrust blocking unless otherwise approved. The method proposed or disposal of wastewater from hydrostatic tests and disinfection shall be submitted to the Owner prior to performing hydrostatic tests. Use clean potable water for all testing of lines.

B. Pressure Test: Pressure test in strict conformance with AWWA C600, Section 4.1 and AWWA Manual of Practice for M23. For purposes of testing, working pressure shall be 100 psi and test pressure shall be 150 psi. Air testing will not be accepted (ONLY Hydrostatic testing is allowed).

C. Leakage Test: Test for leakage concurrent with the pressure test and in strict conformance with AWWA C600, Section 4.2 and AWWA Manual of Practice M23. Remedy all visible leaks and locate and repair leakage in lines which exceed the specified amounts.

3.09 FIELD QUALITY CONTROL

A. Field inspection, sampling and testing will be performed per Owner's instructions.

PART 4 PAYMENT

4.01 PAYMENT

Payment for this section shall be made based on the actual measurement of work at the contract unit price.

END OF SECTION 333123

SECTION 333215 – W ASTEWATER PUMP STATIONS STARTUP

PART 1 GENERAL

1.01 WORK INCLUDED

A. This section gives the requirements for installation of a duplex submersible pump stations including valves, pumps, controls, piping and wetwell.

B. Pumps and pump mounting rails shall be by the same manufacturer so as to insure suitability and assurance of experience in matching the equipment together and to insure single source responsibility for the equipment.

1.02 RELATED WORK

A. Section 02220 - "Excavating, Grading, Trenching and Backfilling"

B. Section 02732 - "Wastewater Force Mains"

C. Division 16 - All Sections

1.03 REFERENCES

A. ASTM D1785 - Poly (Vinyl Chloride) (PVC) Plastic Pipe.

B. ASTM D2467 - Socket - Type Poly (Vinyl Chloride) PVC plastic pipe fittings, schedule 80.

C. ASTM C478 Precast Concrete Manhole Risers and Tops.

PART 2 PRODUCTS

2.01 PIPING AND VALVES

A. Piping: Pump Station pipe and fittings shall be Class 50 ductile iron conforming to ANSI/AWWA CI50/A21.50, all flanged inside station structures and mechanical joint outside station structures, all as shown in the plans.

B. Plug Valves: All valves shall be of the non-lubricated eccentric type with resilient faced plugs and shall be furnished with flanged joint connections.

Port areas for valves through 20" shall be minimum 80% of full pipe area and port areas of 24" and larger valves shall be minimum 70% of full pipe area.

Valve pressure ratings shall be 175 PSI through 12" and 150 PSI through 72". Each valve shall be given a hydrostatic and seat test with test results being certified by the specifications. Certified copies of proof-of-design test reports shall be furnished as outlined in AWWA C504-80, Section 5.5.

All valves 8" and larger shall be equipped with gear actuators. All gearing shall be enclosed in a semi-steel housing and be suitable for running in a lubricant with seals provided on all shafts to prevent entry of dirt and water into the actuator. The actuator shaft and the quadrant shall be supported on permanently lubricated bronze bearings. Actuators shall clearly indicate valve position and an adjustable stop shall be provided to set closing torque. All exposed nuts, bolts and washers shall be type 316 stainless steel or better.

Valves and gear actuators for buried or submerged service shall have seals on

all shafts and gasket on the valve and actuator covers to prevent the entry of water. Actuator mounting brackets for buried or submerged service shall be totally enclosed and shall have gasket seals. All exposed nuts, bolts, springs and washers shall be stainless steel. Valves 6" and smaller shall be quarter-turn. All vaulted valves shall have flanged joint connections with 4" hand wheel and non-rising stem.

Valve bodies shall be of cast iron (ASTM 126 Grade). Bodies in 3" and larger valves shall be furnished with a welded overlay seat of not less than 90% pure nickel in accordance with AWWA C507 Section 7.2. Seat area shall be raised, with raised surface completely covered with weld to insure that the plug face contacts only nickel. Valves utilizing resilient seats attached to the body shall not be acceptable. As per AWWA C-504-80 Section 325.3 and AWWA C507-73 Section 7.2, sprayed or plated seats are not acceptable, nor shall screwed-in seats be acceptable.

Plugs shall be cast iron (ASTM 126 Grade B). The plug shall be of one piece construction and shall be capable of withstanding the full pressure rating of the valve without the use of additional structural reinforcing ribs that extend beyond the profile of the plug itself. Plugs shall be resilient faced with hypalon suitable for use with chemical applications. Plugs with cast inlays shall not be acceptable. Valves shall be sleeve type metal bearings conforming to AWWA C504-80, Section 3.6 and AWWA C507.73, Section 8. Bearings shall be of sintered, oil impregnated and permanently lubricated type 316 ASTM A743 Grade CF-8M or AISI Type 317L stainless steel in ½" - 24" sizes. Non-metallic bearings shall not be acceptable.

Valve shaft seals shall be of the multiple V-ring type and shall be externally adjustable, repackable without removing the bonnet or actuator from the valve, and repackable under pressure. Shaft seals shall conform with AWWA C504-80, Section 3.7 and AWWA C507-73, Section 10.2. Valves utilizing o-ring seals or non-adjustable packing shall not be acceptable. All exposed nuts, bolts, springs, washers, etc., shall be type 316 stainless steel or better for buried and above ground valves.

DeZurik (figure 118) eccentric plug valves and actuators shall be the basis for design or approved equal.

C. Check valves shall be suitable for mounting in the horizontal or vertical position, Class 30 cast iron, bronze mounted, swing check valves designed for 175 psi differential pressure. All materials in contact with liquid shall be resistant to sanitary sewage. Provide with Class 125, ANSI B16.1 flanged connections. Hinge shaft shall be 316 or better stainless steel. Valve shall be provided with a weighted lever for water hammer prevention. Valves shall be manufactured by Mueller or equal and furnished by the pump manufacturer.

2.02 SUBMERSIBLE PUMPS AND LIFT OUT SYSTEM

A. General: Pump stations shall be mounted and capable of pumping raw, unscreened sewage without clogging. Pumping units shall be automatically and positively connected to the discharge piping when lowered into place on a guide rail system, requiring no bolts, nuts or fasteners to seal pump watertight to discharge piping. Furnish combination support base and discharge elbow, guide rail assembly, access cover, lift chains, heat sensors and seal failure probes. Heat sensing units shall be embedded in the motor winding in order to trip the starter if the motor overheats. Pumps shall be supplied by Myers or by a manufacturer that has produced wastewater pumps for at least 5 years and manufacturers the pumps in the U.S. and has a repair facility located within 250 miles of the Owner. The Engineer shall select pumps, impellers and motor

from a list of Town of Kure Beach approved pumps.

B. Pump Performance:

1. Supply submersible pumps with the operating parameters as specified in the plans or within the contract documents at least meeting minimum design condition with a whole size impeller to be approved by the owner, 1800 RPM maximum speed, being able to pass a minimum of a 3 inch solid.

C. Pump Construction

1. Materials of Construction. Furnish unit components meeting or exceeding the following material specifications.

(a) Pump Case	Cast Iron - ASTM A48 Class 30A
Motor Housing	Cast Iron - ASTM A48 Class 30A
Impeller	Cast Iron - ASTM A48 Class 30A
Motor & Pump Shaft	Stainless Steel - ANSI Series 300
or 400 Wear Ring Materials	Corrosion and Wear Resistant
"O" Rings	Buna-N or Nitrile Rubber or Neoprene

(b) Coat all cast-iron parts with corrosion resistant paint.

2. Pump Design. Provide pumps capable of handling raw, unscreened sewage. Design pump to allow for easy removal without requiring entering the wet well and without requiring bolts, nuts or other fastenings to be disconnected.

Install pump unit to discharge connection with a simple downward motion without rotating. Provide necessary sliding guide bracket and discharge connection which when bolted to the floor of the sump and to the discharge line will receive the pump discharge connecting flange without need of adjustment, fasteners, clamp, or similar devices. No portion of the pump shall bear directly on the floor of the wet well. Provide watertight sealing between pump discharge and elbow.

3. Impeller. Provide non-clog type dynamically balanced impeller. Provide wear ring as necessary to assure efficient sealing between volute and impeller. Impeller diameter to be a whole size approved by the owner.

4. Discharge Connection and Guide Rails. Permanently install discharge connection elbow in wet well along with discharge piping. The discharge piping shall have a polyethylene spacer installed between the supporting U-bolt clamps and the discharge piping. The polyethylene shall be 1/8 inch thick, UltraPoly or equivalent, and extend a minimum of 1 inch above and below each U-bolt. Provide sliding guide bracket integral to pump unit. The entire weight of the pumping unit shall be guided by guide rail(s) and press tightly against the discharge connection elbow. The guide rail(s) shall not support any portion of the weight of the pump.

Provide corrosion-resistant 316 or better stainless steel schedule 40 guide rails and stainless steel lifting chains. Chains to be of sufficient strength to lift pumps from sump and shall be of sufficient length to extend 4' above access hatch with pumps in place. Furnish guiding rail assembly and the discharge flange assembly of non-sparking components. Guide rail base shall be anchored with diameter 3/4 inch x 4 inch 316 or better stainless steel anchor bolts.

5. Shaft Seal. Seal shaft with double mechanical type seal running in an oil-filled chamber. The lower seal between the pump and oil chamber shall contain one stationary and one rotating tungsten-carbide ring. The upper seal between the oil sump and motor housing shall contain one stationary

ceramic or tungsten- carbide ring and one rotating carbon ring. All metal parts of seal to be type 316 stainless steel or better.
Provide seals requiring neither routine maintenance nor adjustment, but capable of being easily inspected and replaced. Hold each interface in contact by its own spring system.

6. Motors. Provide motor of totally submersible design, as specified in the plan or within the contract document, constructed with epoxy or poly-seal encapsulated windings, oil or air-filled, with Class F Insulation and rated for continuous duty operation. Motor shall be 3 phase, 60 cycle, with a 1.15 service factor. Provide motor of adequate horsepower to operate pump at any point on its curve without overload or operation in the SF. Insure motor is capable of running dry for extended periods without damage to motor or seal. Each motor shall be equipped with 50 feet of type SEOW cable power, control cable where required shall also be type SEOW when available, capable to withstand pull of 300 pounds to meet UL requirements, cable shall be double sealed and sized for the motor horsepower.

D. Lift Out System: Each pump shall be installed and removed conveniently from its support - discharge elbow by manually lifting pump with 316 stainless steel or better chain lift, along 316 stainless steel or better standard weight pipe guide system, supported at the top by an upper guide bracket and at the bottom by the support elbow. The weight of the pump shall compress a gasket or bear against an accurately machined fitting to seal the mating surfaces against leakage when seated. Pump manufacturer shall provide all type 316 or better stainless steel external fasteners and adjusting bolts, stainless steel anchor bolts, stainless steel guide rail(s), rail support bracket, lift chain sized for the required load. Lift out system shall be of latest design and pump manufacturer.

2.03 WET WELL

A. Wet well shall be precast concrete manhole conforming to ASTM C478 with tops and base sections as shown on the drawings. Joints between sections shall be tongue and groove with elastomeric gaskets. Provide aluminum ladder as shown on drawings. Connections for jointing pipe to the manhole shall conform to ASTM C923. All fasteners, wedge anchors, bolts, hooks, etc. shall be type 316 stainless steel or better, no mild steel will be allowed in wet well or valve vault. A support grip shall be supplied and installed for each float and power cord. Support grip shall be "Hubbell" closed mesh series 024-17-XXX approximately sized for each cord.

B. Basin Cover: Single leaf lockable with matching eye and padlock, raintight aluminum hatch of size and dimension as shown on drawings and in any event must allow unrestricted maintenance access for pump retrieval and reset. Hatches shall be manufactured by Halliday Products, Inc. or equal.

C. Manufacturer shall core drill or cast all openings greater than 2 inches diameter through the pump station walls and provide an approved elastomeric boot, sleeve or adapter for connecting sewers and force main indicated on the drawings.

D. Concrete compression strength shall be 5,000 psi at 28 days. Minimum wall thickness shall be 5 inches for 5 foot diameter, 6 inches for 6 foot diameter and 8 inches for 8 foot diameter sections. Provide minimum 3/4 inch cover over all steel reinforcing. Base section shall include a 1' extended base unless otherwise specified.

E. Wet well top shall be set a minimum of 2' above 100 year flood elevation.

F. The Pump Station shall be accessible via a service access road that is constructed at a minimum of 2 feet above the 100 year flood elevation.

G. Interior of wetwell shall be coated with Zebron 386, Duramar 1030 as manufactured by Sewerkote or equal as approved by the engineer. Coal tar epoxy linings or Raven Lining Systems are not acceptable. The lining shall be applied after the wetwell has been installed. The interior surface or the wetwell shall be clean, dry, and free of all oil, grease, or other contaminants as required by the manufacturer of the lining product.

2.04 STANDBY GENERATOR SLAB

A. Generator slab shall be a minimum of 10' X 7' concrete slab, minimum 12 inches thick, with #4 rebar set 12 inch on center, each way, and also 1/3 of the height of the slab, as measured from ground elevation and with compressive strength of 5,000 psi at 28 days, with a rectangular opening at one end for all required electrical conduits, and capable of supporting a 7,000 lbf, 40 kW emergency generator, minimum, and sized accordingly for any required larger generators.

2.05 CONTROL PANEL

A. General: Control panel shall consist of a circuit breaker and magnetic starter for each pump motor and a liquid level control system with all components mounted in one common enclosure. The controls assembly shall provide means to operate each pump manually or automatically. When operated in the automatic mode, the control assembly shall provide a means to manually select or automatically alternate the position of the "lead" and "lag" pump after each pumping cycle. Power supply shall be voltage as specified in the plans or within the contract documents, 3 phase, 4 wire as shown. Control supply shall be 120 volt, 1 phase.

B. Enclosure: The electrical control equipment shall be mounted within a NEMA type 4X dead front enclosure, molded of fiberglass reinforced polyester resin or equivalent. The enclosure shall have quick release latches and a hasp assembly for padlocking. Control compartment shall incorporate a removable back panel on which control components shall be mounted. Back panel shall be secured to enclosure with collar studs. The back panel shall be heavy gauge steel or white painted steel painted with heavy duty epoxy enamel after fabrication. All external hardware, hinges, etc., shall be non-metallic or 300 series stainless steel with a minimum of 36 inches separation between the bottom of enclosure and top of concrete slab. The slab shall be minimum 12 inches thick, with #4 rebar set ½ inch on center, each way and also 1/3 of the height of the slab, as measured from ground elevation and shall be minimum compressive strength of 5,000 psi at 28 days.

C. Operation: A float switch type liquid level control system shall control operation of the pumps according to level variations. The system shall actuate pump motors on an alternating "lead-lag" basis with independently adjustable lead pump and lag pump start levels. One pump motor shall be actuated when wet well liquid rises to a pre-set "lead pump start" level, and shall be shut down when wet well liquid has been pumped down to the pre-set "stop" level. After the lead pump motor has been actuated and the liquid continues to rise and reaches the preset "lag pump start" level, the second pump motor shall be actuated and both pump motors shall continue to operate until the wet well liquid falls to the preset "stop" level. A high level float switch shall energize a local alarm light if the wet well level reaches a preset maximum. An additional high level float shall provide a normally open contact for a telemetry signal. Levels shall be set at elevations as shown on the drawings.

D. Float Switches: Provide five sealed mercury float switches for each duplex lift station to control the two pumps and annunciate high wet well level. Switches shall be enclosed within solid polyurethane floats and suspended in the wet well by Type SO neoprene cable containing No. 18 AWG minimum stranded copper conductors. A sealed, corrosion resistant weight shall be attached to the support cable above the float to hold the switch in place.

E. Components: All motor branch circuit breakers and motor starters shall be Square "D", securely fastened to the removable back panel with screws and lock washers. Back panel shall be tapped to accept all mounting screws. Self tapping screws shall not be used to mount any component.

1. A magnetic molded case circuit breaker shall be furnished for each pump motor and accessory load. Each circuit breaker shall be FAL/KAL MAG guard series and adequately sized to meet the pump motor operating conditions and shall have a symmetrical RMS interruption rating of at least 10,000 amperes.
2. An open frame, across the line, NEMA rated, magnetic motor starter shall be furnished for each pump motor. Starters shall be suitable for addition of at least two front mounted auxiliary contacts. Starters sizes "O" or "OO" are not permitted. Power contacts shall be double breaker and made of cadmium oxide silver. Motor starter contacts and overload relays shall be easily replaceable without removing the motor starter from its mounted position. Overload relays shall be of the block type utilizing melting alloy type spindles and shall have visual trip indication with trip free operation. Overload reset push buttons shall be located on the exterior of the inner panel. Starter coil voltage shall be 120 volts. The motor wire terminations at motor starter shall be set screw box lugs for each conductor.
3. Pump mode, lead-lag, and alarm selector switches shall be oil tight, Hand-Off-Automatic type to permit over ride of automatic level control and manual actuation or shutdown of either pump motor. Operation of pumps in manual mode shall bypass all safety shutdown circuits except pump motor overload shutdown and phase monitor contacts. Switches shall be oil-tight, providing three switch positions, each of which shall be clearly labeled according to function.
4. Provide a two stage pump sequence selector switch to permit override of the automatic alternator by manual selection of the lead and lag pump positions. Switch positions shall be "TEST", "LEAD," and "AUTO" and spring load left return to center.
5. Panel indicators shall be oil-tight, heavy duty. Provide a green "running" lamp for each pump. Controller indicator lamps shall be 120v full voltage transformer type SQD.
6. Motor starter relays shall be enclosed general purpose relays with 8 pin plug-in bases and contacts rated at 120 VAC, 80 percent P.F., 10 amperes.
7. The panel shall be supplied with a properly sized control power circuit breakers.
8. A weatherproof, corrosion-resistant, 20 amp, duplex utility GFI receptacle providing 120 volt power shall be flush mounted on the side of the enclosure. The device shall be Hubbell #8300 with a Daniel Woodhead #60W33 cover with a non-metallic receptacle box on inside of enclosure to protect from accidental contact with receptacle.
9. A non-resetable running time meter measuring hours and tenths of hours of operation up to 99,999.9 hours shall be furnished for each pump motor.
10. A high level alarm light shall be installed on the exterior of the lift station. The fixture shall be heavy duty vaportight, weatherproof type with 100 watt clear lamp and red polycarbonate lens. The lamp shall flash approximately 30 times per minute when energized. The audio alarm device shall be weatherproof vibrating type AC horn. Minimum output at 10 feet shall be 95 decibels. When energized, the horn shall operate. An alarm reset pus-button shall be provided to reset the alarm once the condition has been corrected.
11. High Temperature Shutdown: Each control panel shall be equipped with pump high temperature shutdown system. Each pump shall be furnished with a thermal overload. In a high pump temperature condition, the control shall de-actuate the pump motor.
12. Seal Failure Alarm: Each control panel shall be equipped with a pump seal failure alarm system. Each pump shall be furnished with a moisture sensor and indicator lamp. If moisture is detected in the pump housing, the seal failure panel indicator

lamp corresponding to the pump that experienced the condition shall be energized.

13. Provide a 3 phase, 3 wire lightning arrester for each control panel connected to the incoming power terminal block. Arrester shall be Square D Model J9200-9A or equal by General Electric or Joslyn.

14. All switches, pilot lights, control devices, major components, etc., shall be clearly labeled according to function with engraved plastic lamicore plates, black with white core. Minimum letter size shall be 1/8 inch.

15. All other components necessary for a completely operable system performing the functions required shall be supplied.

F. Operating Controls and Instruments: All operating controls and instruments shall be securely mounted in such a manner that any or all standard options specified may be added without rearrangement of existing controls and instruments. All controls and instruments shall be clearly labeled to indicate function.

G. Wiring: All wiring workmanship and schematic wiring diagrams shall be in compliance with applicable standards and specifications for industrial

controls set forth by the Joint Industrial Council (JIC), National Machine Tool Builders Association (NMTBA), National Electrical Code (NEC), Division 16 of these specifications and other pertinent electrical codes and standards.

All motor circuit wiring from the distribution block to the circuit breaker and to the motor starter shall be THHN stranded copper. All control circuit wiring shall be MTW 14 ga. tinned red, white, and green. All conductors shall be copper, color coded and clearly numbered at each end in conformance with applicable schematic wiring diagrams, and of adequate size to safely carry required electrical loads. All control wires shall be marked using T&B Shur code sleeve markers. All wires on the back panel shall be contained in wire troughs with removable covers to facilitate field repairs and addition of optional/additional components. Splices shall not be used on any wires.

H. Shop drawings adequate for control panel fabrication, installation and maintenance shall be submitted and approved prior to manufacture. Drawings shall include an elementary control (ladder) diagram, interconnection wiring (schematic) diagram, interior and exterior panel component layout drawings, component catalog cuts and Contractor's installation drawings. The adequacy of shop drawings shall be determined solely by the Owner.

2.06 EQUIPMENT

A. Pressure Gages: Pressure gages shall be furnished for installation as specified below. They shall be 3 inch minimum diameter, glycerin filled with stainless steel case. Bourdon tubes shall be stainless steel, 1/4 inch NPT male bottom connection, stainless steel rack and pinion movement micro-adjustment for calibration, white dials and black figures, and threaded ring case. Gages shall read in feet of head. Gages shall be furnished with stainless steel diaphragm, factory mounted. Gages shall be installed with Type 316 or better stainless steel nipples, no shorter than 2 inches, and tee handle cock. Gages shall be manufactured by U.S. Gage, a Division of Ametek, Inc., Sillersville, PA, Crosby-Aston Valve Co., Wrentham, MA, or equal.

<u>Pressure Gages Required</u>:

Location – Pump Discharge

Range - 0-140 feet

B. Station Padlocks: The Contractor shall provide six (6) resettable combination padlocks. They shall be double locking, solid brass case, and have nickel-plated shackles. They are to be Master No. 175-LH or Corbin No. 436. They are to be included with the lump sum price with each pump station.

PART 3 EXECUTION

3.01 SHOP DRAWINGS AND O&M MANUALS

A. General: The Contractor shall submit six (6) sets of shop drawings certified prints, literature and cuts to the Owner for all pumping equipment, control panels and accessory materials for review and approval. Certified pump curves shall be provided showing total dynamic head versus flow, efficiency, brake horsepower, NPSH required by pump, and minimum submergence required over pump suction.

Furnish four (4) sets of operations and maintenance (O&M) manuals for each pump station's pumping equipment. O&M Manual shall be indexed and shall contain spare parts list, installation instructions, lubrication instructions, operating instructions, and repair and service manual for each pump furnished. All manuals must be specific for all equipment furnished. Generic manuals will not be allowed.

B. Contractor shall provide any special tools specific to the equipment provided which is needed to perform maintenance and as recommended by the equipment manufacturer.

3.02 INSTALLATION

A. General: The Contractor shall receive, handle and store all equipment and materials to be installed, being careful to prevent any damage during transport and storage. All equipment stored shall be protected from weather in a manner recommended by the manufacturer.

1. All equipment shall be handled and installed in accordance with written instructions and approved shop drawing details of the manufacturer and as required by the drawings. Anchor bolts shall be carefully placed in exact position using template or other approved method.
   Aluminum access door frame, where to be in contact with concrete, shall be shop primed or field coated with zinc chromate, or equal, primer immediately upon delivery to the job.
2. If the Contractor determines that existing conditions do not permit proper installation, he shall immediately notify the Engineer.
3. Pipe work shall be carefully assembled and placed so as not to put strain on the pumping equipment and support elbow. All joints shall be gasketed gradually and evenly tightened watertight. Pipe work will be tested in accordance with these specifications. All pipelines through walls of station shall be installed absolutely watertight, showing no visible signs of seepage or infiltration.
4. Conduit/wiring shall run directly between equipment with no horizontal bends.

B. The Contractor shall provide all recommended lubricants for start-up of each item of equipment.

C. All pumps, control panels and accessory equipment shall be installed in strict accordance with the manufacturer's instructions and good practice in a workmanship manner. All quick disconnect pumps shall be retrieved and reset to demonstrate proper installation for each pump station and witnessed by a representative of Town of Kure Beach Engineering Department.

3.03 START-UP SERVICES AND TESTING

A. The pumping manufacturer shall provide the services of a representative for a minimum of five (5) days to provide start-up and follow up advisory service, including O&M instructions to the operating personnel. Representative shall schedule at least two separate trips for these services. The Owner shall be notified when manufacturer's representative is to be at the work site one week in advance to be present during start-up of equipment.

B. Pump Test: Secure from the pump manufacturer performance of following inspections and tests on each pump before shipment from factory:

1. Impeller, motor rating and electrical connections shall first be checked for compliance

with the job requirements.

2. Motor and cable insulation test for moisture content to insulation defects shall be made.
3. Prior to submergence, run pump dry to establish correct rotation and mechanical integrity.
4. Run pump for 30 minutes submerged, a minimum of six (6) feet under water.
5. After operational test No. 4, Perform insulation test (No. 2) again.

Seal pump cable end with a high quality protective covering to make it impervious to moisture or water seepage prior to electrical installation.

Test pumps, motors, and controls in operation in accordance with the standards of the Hydraulic Institute. Certified records of the test shall substantiate the operation of the equipment at the design head, capacity, and horsepower as specified.

C. LEAKAGE TESTING

1. Conduct a visual inspection of concrete wet wells and valve vaults. Repair all visible and detectable leaks.
2. Leakage Testing for Wet Wells. Wet wells shall be leakage tested prior to backfilling by the following procedures:
   (a) Temporarily plug all wall sleeves, piping entrances, and other openings during test period.
   (b) Fill structure to overflow level.
   (c) Allow to stand for a minimum of four (4) hours.
   (d) Refill to overflow level.
   (e) Allow to stand for 24 hours.
   (f) Examine exterior surfaces and joints for leakage. Measure drop in surface water.
   (g) Allowable leakage is a drop of ½ inch or less during the test period and no visible signs of leakage.
   (h) Repair all visible and detectable leaks. If leakage exceeds the allowable limit, the structure shall be repaired by method approved by the Engineer.

PART 4 PAYMENT

4.01 Payment: Payment for this section shall be made based on the lump sum price shown in the contract proposal form. Partial payment may be considered at the sole discretion of the owner and the engineer.

END OF SECTION 333215

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SECTION 334100 – STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

A. The Contractor under this section is responsible for the removal, re-installation and/or installation of all storm water drainage pipes, manholes, headwalls, and other related structures per the plans. Installation will conform to the requirement as specified in the North Carolina Department of Transportation (NCDOT) "Standard Specifications for Roads and Structures."

B. Submittals:

1. Shop Drawings: Contractor shall furnish to Owner or Owner's representative shop drawings and material specification sheets of all material and items to be installed or delivered as specified in Section 017839.

PART 2 - PRODUCTS

2.1 Pipe:

A. Reinforced Concrete Pipe: ASTM C76, Class III with tongue and groove joints and preformed mastic joint filler. In structural areas where less than 2 feet of cover over pipe cannot be achieved, use Class IV RCP.

B. Roof drain header pipe shall be C900 DR18 PVC or Ductile Iron Pipe (Class 52, Cement Lined) as shown on the plans.

C. Trench drain outfall pipe shall be Ductile Iron Pipe (Class 52, Cement Lined).

2.2 Drainage Structures: Manhole and inlet structures shall be precast concrete with preformed holes or knockout panels unless otherwise approved. All manholes and inlet structures shall be H20 load rated. Specifications for replacement item shall be as follows:

A. Precast Concrete Manholes: ASTM 478 with eccentric cone tops and precast base sections, unless shown otherwise. Manholes less than 4 feet deep shall have flat slab top. Minimum inside diameter of base section shall be 4 feet, with actual diameter to be determined by the Contractor and manhole supplier based on the number, size, and angle of pipe connections for each manhole. All manholes shall be H20 load rated.

B. Precast Concrete Inlet Boxes: Boxes shall be constructed in accordance with ACI 318, designed for H20 live loads, with knockout panels all four sides. Minimum inside area of box shall be 5 square feet.

C. Steps: ASTM C478, polypropylene encapsulated Grade 60 steel bars.

D. Frames, Grates, and Covers: Cast Iron conforming to ASTM A48, Class 30B. Dimensions shall conform to the Drawings in essential details.

2.3 FLARED END SECTIONS

Concrete: reinforced concrete AASHTO M170.

2.4 Filter Fabric: Filter fabric shall be non-woven synthetic fabric conforming to NCDOT Section 956-1.

PART 3 - EXECUTION

3.1 Related Work: Excavated, trenching, backfilling, and compaction shall be in with Technical Specification 312000, "Excavation Grading, Trenching, and Backfilling for Utility Systems. Proper clearance of water, sewer and other utilities shall be provided.

3.2 Pipe: Pipe shall be new pipe, free of defects. Store in an acceptable manner until ready for installation. The pipe shall be installed from the lowest point of the system, true to line and grade, with bell or groove and facing upstream. The trench shall be maintained free of surface or ground water. Installation shall conform to the respective recommendations of the pipe manufacturers or trade association) except as modified hereafter. In addition, each joint of pipe shall be wrapped with 4' wide woven fabric that is overlapped on top by a minimum of 2'. Top of fabric at overlap shall be zip tied together.

Material Properties			
Property	**Test Method**	**Units**	**M.A.R.V. (Minimum Average Roll Value)**
Grab Tensile	ASTM D4632	lbs (kN)	200 (0.889)
Grab Elongation	ASTM D4632	%	15
Trapezoid Tear Strength	ASTM D 4533	lbs (kN)	75 (0.333)
CBR Puncture Strength	ASTM D6241	lb (kN)	700 (3.11)
Permittivity*	ASTM D4491	sec^{-1}	0.05
*Property determined at the time of manufacturing. This product is imported. Handling, storage and shipping may alter these properties.			

A. Concrete Pipe: ACPA "Concrete Pipe Installation Manual."

B. Provide minimum 1 foot over pipe prior to allowing traffic over trench. Clean pipe of all debris and soil after construction.

3.3 Structures

A. Bedding: Provide 8 inches of #57 washed stone beneath structures to 1 foot outside of structure.

B. Precast structures shall be set plumb, with pipes centered within knockout panels. Provide opening of minimum size to accommodate pipe. Grout pipe in place with non-shrink grout.

C. Inverts shall be performed or formed with concrete or brick and concrete. Provide 1 inch per foot slope to the flow line of the structure.

D. Steps: For structures greater than 3 feet deep, provide steps 12 inches apart with alternate steps offset 6 inches horizontally, beginning two feet below top of frame. Install in conformance with manufacturers recommendations.

E. Frames and Grates: Frame and grates shall be heavy duty H20 load rated. Center frame castings above structure opening. Adjust to grade with precast concrete grade rings, brick, or mortar for a maximum adjustment of 12 inches.

END OF SECTION 334100

SECTION 40 71 00

MAGNETIC FLOW METER

PART 1 GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish, install, calibrate, test, start-up, and place in satisfactory operation a magnetic flow meter.

B. Related Sections:
   1. Section 09 91 00 – Painting and Protective Coatings.
   2. Division 26 Sections.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ISA 5.1, Instrumentation Symbols and Identification.
   2. ISA 5.4, Instrument Loop Diagrams.
   3. ISA 20, Specification Forms for Process Measurement & Control Instruments, Primary Elements & Control Valves.
   4. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   5. UL 50, Safety Enclosures for Electrical Equipment, Non-Environmental Considerations.
   6. UL 508A, Industrial Control Panels.
   7. UL 698A, Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations.
   8. UL 2062, Enclosures for Use in Hazardous (Classified) Locations.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer: Manufacturers of magnetic flow meters furnished under this Section shall be experienced producing similar equipment and shall have the following qualifications:
      a. Shall manufacture magnetic flow meters that are fully-developed, field-proven, and of standardized designs.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Manufacturer's product name and complete model number of devices proposed for use, including manufacturer's name and address.
      b. Data sheets and manufacturer's catalog literature.
      c. Description of construction features.
      d. Performance and operation data.

e. Installation, mounting, and calibration details; instructions and recommendations.
f. Service requirements.
g. Dimensions of magnetic flow meter and details of mating flanges and upstream/downstream straight run pipe lengths required.
h. Range of each device and calibration information.
i. Descriptions of materials of construction and listing of NEMA ratings for equipment.

2. Product Data:
   a. Manufacturer's literature, illustrations, specifications and engineering data including; dimensions, material size, weight and parts list for all components in sufficient detail to allow an item-by-item comparison with the Contract Documents.

B. Informational Submittals: Submit the following:
1. Manufacturer's Instructions:
   a. Shipping, handling, storage, installation, and start-up instructions.
2. Source Quality Control Submittals:
   a. Factory test reports and results.
3. Special Procedure Submittals:
   a. Submit written procedure for system checkout to ENGINEER.
   b. Submit notification to OWNER and ENGINEER at least 14 days before readiness to begin system checkout, but not prior to Town of Kure Beach Approval of the checkout procedure. Schedule system checkout on dates agreed to by OWNER and ENGINEER.
4. Field Quality Control Submittals:
   a. Submit the following prior to commencing system checkout and start-up.
      1) Completed calibration sheets for magnetic flow meter showing five-point calibration (0, 25, 50, 75, 100 percent of span), signed by factory-authorized serviceman.
   b. Field calibration reports
   c. Field testing reports.
5. Supplier's Reports:
   a. Installation inspection and check-out report.
   b. Submit written report of results of each visit to Site by Supplier's service technician, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
6. Qualifications Statements:
   a. Manufacturer, when required by ENGINEER.

C. Closeout Submittals: Submit the following:
1. Operations and Maintenance Data:
   a. Include acceptable test reports, maintenance data and schedules, description of operation, wiring diagrams, and list of spare parts recommended for one year of operation with current price list.

D. Maintenance Materials Submittals: Submit the following:
1. Spare Parts and Test Equipment:
   a. Provide replacement spool piece where bypass piping is not provided.
   b. Transmitter.

c. Furnish a recommended list of additional spare parts and test equipment and itemized price.

1.5 STORAGE AND HANDLING

A. Prior to packaging, each manufacturer or Supplier shall securely attach tag number and instructions for proper field handling and installation to each instrument.

B. Comply with Section 01 60 00 - Product Requirements.

PART 2 PRODUCTS

2.1 MAGNETIC FLOW METERS

A. Manufacturers:
   1. ABB Magmaster, plus MFF.
   2. Emerson/Rosemount 8700 Series.
   3. Toshiba LF 654 Series.
   4. Or as approved.

B. Method of Operation: Produce a pulsed DC magnetic field that, when applied to a conductive liquid, generates an induced voltage as the liquid flows through the magnetic field. Generate voltage directly proportional to the flow of the metered liquid. Identify the ratio of flow velocity to voltage generated for all meter sizes, thereby permitting primary head and transmitter direct adaption and interchangeability without circuit modifications or system recalibration.

C. Performance Requirements:
   1. Range:
      a. Minimum Flow Rate: <0> GPM (Engineer to provide).
      b. Maximum Flow Rate: <200> GPM (Engineer to provide).
      c. Average Flow Rate: <85> GPM (Engineer to provide).
   2. Indication: Provide remote panel mounting for digital display of flowrate and totalized flow.
   3. Accuracy (with analog output):
      a. ±0.5 percent of flow rate, or better, over a range from 1 fps to 31 fps.
      b. ±0.005 fps, or better, at flows below 1 fps.
      c. Accuracy unaffected by changes in fluid velocity, density, pressure, temperature or conductivity (above minimum conductivity limits).
      d. System accuracy shall be proven by submittal of flow test curves of the actual meters being furnished.
         1) Test curves shall show a minimum of ten equally spaced flow points. Tests shall be performed using water and a weight or volume tank. A "master meter" used as a reference standard is not acceptable.
   4. Repeatability: ±0.15 percent of flow rate, or ±0.0015 fps, whichever is greater.
   5. Drift: Complete zero stability.
   6. Minimum Fluid Conductivity Limit: Five microsiemens per centimeter or less.
   7. Minimum Pre-amp Input Impedance: 1012 ohms.

8. Power:
   a. 120 VAC ± 10 percent, 60 Hz, ±3 Hz power supply.
   b. Power Consumption shall not exceed 50 watts for flowtube and transmitter combined.
9. Output:
   a. 4 to 20 mADC, direct acting and isolated, into 0 to 1000 ohms.
   b. High accuracy, field adjustable scaled pulse output (0.1 to 10 Hz or greater) to drive local totalizer.
10. Operating Temperature: Suitable for operation with process fluid temperature from 0° to 140°F.
11. Pressure Rating: Greater than or equal to 150 psi or test pressure specified in Section 33 05 05.31, Hydrostatic Testing, for appropriate piping system.

2.2 FLOW TUBE

A. Size: <4> inches.

B. Flow Tube Material: Type 304 stainless steel.

C. Housing:
   1. Material: Carbon steel with corrosion-resistant polyurethane paint finish.
   2. Pressure Rating: 150 psi minimum.

D. Liner Material: Neoprene, Polyurethane, or Teflon (PTFE).

E. Electrodes Design and Material: Type 316L stainless steel or Hastalloy C.

F. Minimum Conductivity: 5 uS/cm (20 uS/cm for demineralized water).

G. Grounding Rings:
   1. Provide each primary head with two grounding rings installed on each end of the primary head.

H. Accidental Submergence Ratings: IP67; accidental submergence to 30 feet for up to 48 hours.

I. Zero Stability: Provide a sero stability feature as an inherent characteristic of the flowmeter system to avoid zero drift.

2.3 FLOW TRANSMITTER

A. Description: Microprocessor-based transmitter unit requiring no calibration over its expected life, under normal use.

B. Power Supply: Operate meters from 120 VAC (±1 percent) at 60 Hz (±5 percent). Factory-wire and assembly primary head and transmitter components, ready for external field connections. Provide required lengths of shielded signal cable for connecting the primary head and transmitter for the raceway route as detailed.

C. Housing: NEMA 4X enclosure; remotely mounted as indicated in the Schedule at the end of this Section.

D. Accuracy:
   1. ±1.0 percent of flow rate or better for flows above 1 foot/second.
   2. ±0.5 percent of flow rate or better for flows avove 2 foot/second.

E. Low Flow Cutoff: Adjustable low flow cutoff set point. Output shall be driven to zero (4 mAdc) when flow falls below low flow cutoff point.

F. Empty Pipe Detection: Drive output to zero (4 mAdc) when empty pipe is detected.

G. Totalization: Provide totalization of flow for direction of measured flow.

H. Temperature Range: -18 to 60 degrees C.

I. Outputs:
   1. 4-20 mA 0 to 1000 ohms, providing 50 megohms of isolation from ground, and isolated from the transmitter's power supply. Minimum of 250 ohms is required for HART communicator.
   2. Pulse output with minimum time duration of 0.5 seconds.

2.4 ACCESSORIES

A. Mounting:
   1. Provide complete Type 316 stainless steel mounting hardware for all transmitter and driver electronics locally mounted and remotely mounted from the flow tubes.
   2. Type of mounting (wall, support frame or pipe stand) as required inside vault and remote enclosure.

B. Shielded cable assemblies of sufficient length for connection between flowtube and transmitter electronics.

C. Type 316 stainless steel grounding rings for flowtubes.

D. Type 316 stainless steel grounding straps.

2.5 AC POWER ON-OFF SWITCH

A. Function: Local power on-off selector switch for magnetic flowmeters. All four-wire transmitters shall be provided with a 120 VAC power on-off selector switch located at the instrument.

B. Construction Features:
   1. Selector Switch: NEMA 4X rated, SPDT.
   2. Enclosure: NEMA 4X rated, non-metallic.
   3. Products and Manufacturers: Provide one of the following:
      a. Allen Bradley 800H rosite glass polyester enclosure.
      b. Or Pre-Approved equal.

2.6 SOURCE QUALITY CONTROL

A. Section 01 40 00 – Quality Requirements.

B. Provide shop inspection and testing of meters.

C. Certificate of Compliance:
   1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
   2. Spedified shop tests are not required for Work performed by approved manufacturer.

PART 3 EXECUTION

3.1 INSTALLATION

A. To create optimum flow conditions, install meter with the manufacturer's recommended straight length of pipe on the inlet side and outlet side of meter. Consult with specific meter manufacturer for optimum installation instructions.

B. Installation in accordance with manufacturer's instructions.

C. Grounding:
   1. If the magnetic flowmeter does not provide a continuous flange-to-flange conductive path outside the area of the magnetic field, install ground rings and connect to each other with a No. 6 AWG ground wire.
   2. Ground magnetic flowmeter to the structure ground with a No. 6 AWG ground wire.

D. Electrical work for underground and potential flooding areas:
   1. Install drip leg in the conduit system and slope conduit downward away from magnetic flowmeter. Provide drain fitting in low part of conduit system to drain conduit system.
   2. Seal conduit entrance into magnetic flowmeter with RTV silicone sealant.
   3. Follow manufacturer's instruction as required to maintain IP67 or IP68 rating.

E. Support piping adjacent to meter such that no weight is carried on meter casings.

3.2 CALIBRATION

A. Factory-set full-scale output to maximum flow rates.

B. Calibrate pulse output to provide a pulse every 1,000 gallons.

3.3 MANUFACTURER'S START-UP SERVICES

A. Manufacturer must certify that meter is properly designed and installed.

B. Provide a minimum of 8 hours of service.

END OF SECTION