Tri-House HVAC and Central Plant Improvements

STATE ID#: 20-15705-001

PROJECT MANUAL

THE UNIVERSITY OF NORTH CAROLINA AT WILMINGTON

PROJECT MANAGEMENT
601 SOUTH COLLEGE ROAD,
FACILITIES ADMINISTRATION BUILDING, ROOM 157
WILMINGTON, N.C. 28403

PROJECT MANAGER: Rick Heins
OFFICE PHONE: (910) 962-4169
MOBILE PHONE: (910) 800-1137
FAX: (910) 962-3696
EMAIL: heinsrw@uncw.edu

CONTENTS:

SET NUMBER: ☐

PREBID DATE: July 21, 2020 at 2:00 PM
BID OPENING DATE: August 4, 2020 at 2:00 PM

UNCW PM # 5933

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UNIVERSITY OF NORTH CAROLINA AT WILMINGTON

NOTICE TO BIDDERS

Sealed proposals will be received by the University of North Carolina at Wilmington in Wilmington, North Carolina, Project Management Department, in the Facilities Administration Building, Conference Room #1, up to 2:00 PM on Tuesday, August 4, 2020 and immediately thereafter publicly opened and read for the furnishing of labor, material and equipment entering into the construction of **Tri-House HVAC and Central Plant Improvements.**

Bids will be received for "single prime contract" by Contractors with appropriate license(s) and/or registration. All proposals shall be lump sum.

Complete electronic plans, specifications and contract documents will be made available prior to the Pre-bid Conference to be held on 2:00 PM on July 21, 2020 in Conference Room 1 in the UNCW Project Management Department, in the Facilities Administration Building.

The UNCW Facilities Project # 5933 shall be clearly indicated on the outside of the envelope.

All contractors are hereby notified that they must have proper license and/or registration as required under the state laws governing their respective trades associated within this project.

NOTE: The bidder shall identify on its bid proposal the minority business participation it will use on the project. Forms are included within the Proposal Form in the bid documents. Failure to complete these forms is grounds for rejection of the bid. (GS143-128.2c Effective 1/1/2002.)

General contractors are notified that Chapter 87, Article 1, General Statutes of North Carolina, will be observed in receiving and awarding general contracts.

Plumbing and heating contractors are notified that Chapter 87, Article 2, General Statutes of North Carolina, will be observed in receiving and awarding plumbing and heating contracts.

Electrical contractors are notified that provisions of Chapter 87, Article 4, General Statutes of North Carolina, will be observed in receiving and awarding electrical contracts.

Payment will be made in accordance with section "Requests for Payment" of General Conditions (p.GC-4) and Division I, section 01700 "Contract Closeout" (p.DIV01-3) of Specifications.

No proposal may be withdrawn or modified after the scheduled time for opening of bids for a period of 30 days, except at the discretion of the Owner or as provided by General Statute G.S. 143-129.1.

The owner reserves the right to reject any or all bids and to waive informalities.

UNIVERSITY OF NORTH CAROLINA AT WILMINGTON

INSTRUCTIONS TO BIDDERS

Proposals must be in accordance with the following instructions, requirements and procedures to be eligible for consideration:

1. LICENSE

All bidders are hereby notified that they must be in possession of a current and proper North Carolina Contractor License according to applicable state and local laws at the time of the bid submittal. Bidders are further notified that applicable provisions of Chapter 87, Article 1, North Carolina General Statutes, shall be observed in receiving bids and awarding contracts.

2. SINGLE CONTRACT PROPOSALS

Proposals for the project work shall be submitted under a single general contract proposal for the work described in the Scope of Work. Proposals shall be received under provisions of North Carolina General Statutes, Section 143-131, and Informal Bid Proposals.

3. EXAMINATION OF PLANS, SPECIFICATIONS, AND SITE OF WORK

A. Each bidder shall carefully examine the site of the proposed work, the Form of Proposal, the plans, specifications and any special provisions of the contract documents before submitting a bid. The submittal of a bid shall be considered full evidence that the bidder has made such necessary examinations, that they know and understand the conditions relating to the performance of the work required by the contract documents, and that the bidder has made every provision to operate under existing and stipulated conditions and has included all necessary items for the proper execution of work required by the contract documents.

B. Inspection of the project site shall only be made during normal business hours and only by appointment with the Project Manager. Bidders shall not disrupt Owner operations during the course of such inspections. The University is an extremely active environment, and visiting bidders shall comply fully with safety policies and the instructions of safety officials.

C. Contact: Project Manager: Rick Heins Mobile Phone: (919) 800-1137

4. UTILITY CHARGES

While service or connection charges or fees by serving utility companies are not anticipated in connection with this project, any expenses relating to utility work during the execution of this project are the responsibility of the Contractor. Coordination and scheduling of any utility work to be performed by serving utilities, if required for relocation or temporary disconnection, shall be the responsibility of the Contractor.

5. CLARIFICATIONS AND INTERPRETATION OF DOCUMENTS

Should any bidder be in doubt about the precise meaning or intent of any part of the plans, specifications or other contract documents, or find discrepancies or omissions therein, they shall immediately notify the Owner in writing and request a clarification. The Owner shall issue a clarification or correction by written addendum to all known bidders and to the office where bid documents are exhibited for inspection. The bidder in the spaces provided on the Form of Proposal shall acknowledge receipt of such addenda.

- *The Owner shall not be responsible for any oral instructions.*

6. PROPOSAL FORMS/ PREPARATION OF PROPOSALS

A. Proposals shall be made in strict accordance with the Form of Proposal bound in these documents, and shall be submitted on the supplied form.

B. Bids shall be submitted on an exact copy of the Form of Proposal. Fill in all appropriate blank spaces provided for amounts, contract time, alternates, unit prices and addenda as applicable. Failure to furnish any requested itemized prices may disqualify the proposal. State the total amount bid in figures and in narrative in the proper spaces on the proposal form.

C. No lineation, erasures, adjustments or alterations shall be made to the printed Form of Proposal. In receiving the bids, the Owner will assume that no such alterations have been made. If any such modifications become apparent after acceptance of the bid, they shall not be binding upon the Owner.

D. Changes in any entry shall be made by marking through the initial entry and by inserting the corrected entry adjacent thereto. An authorized representative of the bidder shall initial each such correction in ink. Failure to initial changes to bid may disqualify the proposal.

E. The bidder shall identify on its bid proposal the minority business participation it will use on the project. Forms are included within the Proposal Form in the bid documents (p. HUB-1). Failure to complete these forms is grounds for rejection of the bid. (GS143-128.2c Effective 1/1/2002.)** Statute on last page.

7. MANNER OF EXECUTION

A. If by Sole Proprietor, state by adding "Owner" after the name of the person executing the documents.

B. If by a Partnership, state by adding "Partner" after the name of the person executing the documents.

C. If by a Corporation, indicate if by the President or by Vice-President and attest by the Secretary. Identify the title of office of the executing entities and impress the corporate seal on each signature page of the documents.

D. If the proposal is made by a Joint Venture, each member of the Joint Venture shall execute the document in the above format for Sole Owner, Partner or Corporation, as applicable.

E. If the Contractor License is held by a person other than an Owner, Partner or Officer of the Firm, then the Licensee shall also sign and be a party to the proposal. The title "Licensee" shall be indicated under such signature.

All signatures shall be properly witnessed and sealed.

8. SUBMITTAL OF PROPOSALS

A. Enclose bid documents in an opaque, sealed envelope of sufficient size to accommodate the unfolded Bid documents. Identify the envelope in the upper left-hand corner as follows:

PROPOSAL FOR: UNCW SPECIAL PROJECT PM 5933
Tri-House HVAC and Central Plant Improvements
UNIVERSITY OF NORTH CAROLINA AT WILMINGTON
Name of Bidder: _____
Address: _____
Bidder License No. _____Bidder Phone No. _____

B. Address proposals to:

The Project Management Department
The University of North Carolina at Wilmington
601 South College Road
Wilmington NC 28403-5620

C. Proposals can be received as follows:

a. Submit Bid prior to the bid opening date and time at the following location:

Director of Project Management Department
Facilities Administration Building, Room 157
601 South College Road
The University of North Carolina at Wilmington
Wilmington NC 28403-5620

b. Submit Bid at or immediately prior to the bid opening August 4, 2020 at 2:00 PM at the following location (late arrivals will not be accepted):

Facilities Administration Building, Conference Room #1
601 South College Road
The University of North Carolina at Wilmington
Wilmington NC 28403-5620

D. Label the envelope on both sides **"SEALED BID ENCLOSED- DO NOT OPEN!"**

E. Deliver or mail proposals to the Director of Project Management Department at the address specified above and before the stated time for bid opening as specified in the Notice to Bidders.

9. MODIFICATION/WITHDRAWAL OF BID PROPOSAL

A. Submitted bids may be withdrawn or modified only by written request authorized by the bidder, delivered to the specified address for submittal of bids before the time established for bid opening.

B. Modifications shall be made as follows:

Changes in any entry shall be made by marking through the initial entry and by inserting the corrected entry adjacent thereto. An authorized representative of the bidder shall initial and date each such correction in ink.

No proposal may be withdrawn or modified after the scheduled time for opening of bids for a period of 30 days, except at the discretion of the Owner or as provided by General Statute G.S. 143-129.1.

C. Negligence, omissions or errors on the part of the bidder in preparing his bid or her shall not entitle them to Withdraw or modify their bid after bids have been opened, except as provided by State Statutes, G.S. 143-129.1.

D. Should the successful bidder fail to execute an agreement, the contract may be offered to the responsible Bidder submitting the next lowest bid proposal, at the discretion of the Owner.

10. RECEIPT/OPENING OF PROPOSALS

At the time and place established for the receipt of bids in the Notice to Bidders, every proposal for the specified work received by the Owner within the time specified shall be opened, acknowledged and read, regardless of any irregularities therein. Applicable North Carolina General Statutes shall be observed in receiving, opening and evaluating bids, and awarding contracts, if award is made.

- *The Owner reserves the right to reject any or all proposals and to waive informalities.*

11. AWARD OF CONTRACT

If the Owner elects to award a contract on the basis of bids received, the contract will be awarded to the responsible bidder submitting the lowest proposal, taking into consideration standards of quality, performance and the contract time specified in the proposal documents. The award shall be made as soon as practicable after the receipt of proposals as provided elsewhere in these instructions.

12. BIDDER QUALIFICATION

A. Before awarding a contract, the Owner reserves the right to require the apparent low bidder to qualify as a responsible bidder by furnishing such additional relevant information as necessary, which may include any of the following:

a. Permanent name, address and telephone number of place of business.

b. Present name and trade, and the number of regular employees with proper qualifications for the required work.

c. Financial statement indicating assets and liabilities of the organization, current to within thirty days of the date of bid receipt or other financial information satisfactory to the Owner.

d. Proof of satisfactory performance of projects of similar scope, requiring specialized skills, and experience and workmanship standards required for the work specified.

e. List of names and license numbers of organization members or employees who hold trade or professional licenses or credentials.

f. The name and home office address of the proposed Surety and identification of its authorized agent licensed in North Carolina.

g. List of principal materials and identification of suppliers and sub-contractors entering into the proposed contract work. Such list shall be subject to approval or rejection by the Owner in accordance with provisions of General and Supplementary General Conditions of the Contract.

B. Any other information the Owner may deem relevant as bidder qualifications for the performance of the work required by the terms of the contract documents.

C. Should the Owner adjudge that the apparent low bidder is not the lowest responsible bidder by virtue of the above qualifications that bidder will be so notified.

13. NOTIFICATION OF AWARD: The Owner will notify the successful bidder, in writing, that their bid has been accepted and that the Owner intends to award them the contract, which shall constitute the Notice to Proceed. If an award is made, it will be made via the issuance of a Purchase Contract by UNCW Purchasing Services. The Owner reserves the right to request an extension of the decision to award the contract from the successful bidder for such reasonable time beyond the stated forty-five (45) days as may be mutually agreeable to both parties.

END OF INSTRUCTIONS TO BIDDERS

UNIVERSITY OF NORTH CAROLINA AT WILMINGTON

GENERAL CONDITIONS

GENERAL INSTRUCTIONS

It is understood and agreed that by submitting a bid that the Contractor has examined these contract documents, drawings, and specifications, has visited the site of the Work, and has satisfied their selves relative to the Work to be performed.

1. MATERIALS, EQUIPMENT AND EMPLOYEES

A. The Contractor shall, unless otherwise specified, supply and pay for all labor, transportation, materials, tools, apparatus, lights, power, fuel, sanitary facilities and incidentals necessary for the completion of his work, and shall 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, and 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 a 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. No changes shall be made in the Work except upon written approval and change order of the Owner. Change orders shall be subject to provisions in the current North Carolina Construction Manual.

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 Contractor may select any product meeting this standard, by any manufacturer. When several products or manufactures are specified as being equally acceptable, the Contractor has the option of using any product and manufacturer combination listed. However, the 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, manufactures 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. Substitution of materials, items or equipment of equal or equivalent design shall be submitted to the Owner for approval or disapproval and such approval or disapproval shall be made by the Owner prior to the opening of bids.

E. 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 is adjudged a nuisance to the Owner or if the presence of any workman is considered detrimental to the Work, the Contractor shall order such parties removed immediately from the grounds.

F. The Contractor shall designate a foreman/superintendent who shall direct the work. The foreman /superintendent shall have a work cell phone and supply the number to the project manager.

2. CODES, PERMITS AND INSPECTIONS

A. The Contractor shall obtain the required permits, give all notice and comply with all laws, ordinances, codes, rules and regulations bearing on the conduct of the work under this contract. If the Contractor observes that the drawings and specification are at variance therewith, he shall promptly notify the Owner in writing. If the Contractor performs any work knowing it to be contrary to such laws, ordinances, codes, rules and regulations, and without such notice to the Owner, he shall bear all cost arising their from.

B. All work under this contract shall conform to the North Carolina State Building Code and other state and national codes as are applicable.

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

D. Inspection and certification of compliance by local authorities is necessary if an architect or engineer was not employed on the project, or if the plans and specifications were not approved and the construction inspected by the State Construction Office.

3. SAFETY REQUIREMENTS

A. The Contractor shall be responsible for the entire site and the construction of the same and provide all the necessary protections as required by laws or ordinances governing such conditions and as required by the Designer.

B. The Contractor shall be responsible for any damage to the Owner's property, or that of others on the job, by the Contractor, the Contractor's personnel or the Contractor's subcontractors, and shall make good such damages. The Contractor shall be responsible for and pay for any claims against the Owner arising from such damages.

C. The Contractor 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 11, June 24, 1974 Federal Register), and revisions thereto as adopted by General Statutes of North Carolina 95-126 through 155.

D. The Contractor shall provide all necessary safety measures for the protection of all persons on the work site, 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 Contractor shall clearly mark or post signs warning of hazards existing, and shall barricade excavations and similar hazards. The Contractor shall protect against damage or injury resulting form falling materials and shall maintain all protective devices and signs throughout the progress of the Work.

4. TAXES

A. Federal Excise Taxes do apply to materials entering into State work (Internal Revenue Code, Section 3442 (3)).

B. Federal Transportation Taxes do apply to materials entering into State work (Internal Revenue Code, Section 3475 (b) as amended).

C. North Carolina Sales Taxes and Use Tax do apply to materials entering into State work (N.C. Sales and Use Tax Regulation No. 42, Paragraph A), and such costs shall be included in the bid proposal and contract sum.

D. Local Option Sales and Use Taxes do apply to materials entering into State work as applicable, (Local Option Sales and Use Tax Act, Regulation No. 57), and such cost shall be included in the bid proposal and contract sum.

E. Accounting Procedure for Refund of County Sales & Use Tax:

Amount of County Sales and Use Tax paid per contractor's statements:

Contractors performing contracts for state agencies shall give the state agency for whose project the property was purchased a signed statement containing the information listed in 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 as of April 1, 1991 from the contractor setting forth the date, the type of property and the cost of the property purchased form each vendor, the county in which the vendor made the sale and 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 might be subject to audit. In the event the contractor(s) make several purchases form 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. 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 contractor. Similar certified statements by his subcontractors must be obtained by the general contractor and furnished to the claimant. Contractors are not to include any tax paid on supplies, tools and equipment that 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 a building or structure.

5. EQUAL OPPORTUNITY

A. 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.

B. The Contractor(s) agree not to discriminate against any employees or applicants for employment because of physical or mental handicap in regard to any position for which the employees or applicant is qualified. The Contractor 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.

6. INSURANCE

A. The Contractor(s) shall not commence work until they have obtained all insurance required, and such insurance has been approved by the Owner, nor shall the Contractor allow any subcontractor to commence work on their subcontract until all similar insurance required of the subcontractor has been obtained.

B. The Contractor shall provide and maintain during the life of this contract Workmen's Compensation Insurance for all employees employed at the site of the project under his contract.

C. The Contractor shall provide and maintain during the life of this contract such Public Liability and Property Damage Insurance as shall protect the Contractor and any subcontractor performing work covered by this contract, from claims for damage for personal injury, including accidental death, as well as from claims for property damage which may arise from operations under this contract, whether such operation be by the Contractor themselves or by any subcontractor, or by anyone directly or indirectly employed by either of them and the amounts of such insurance shall be as follows:

- *Public Liability Insurance in an amount not less than $300,000 for injuries, including accidental death, to any one person and subject to the same limit for each person, in amount not less than $500,000 on account of one accident; and Property Damage Insurance in an amount not less than $100,000/ $300,000.*

D. The Contractor shall furnish such additional insurance as may be required by the General Statutes of North Carolina, including motor vehicle insurance in amounts not less than statutory limits.

E. Each Certificate of Insurance shall bear the provision that the policy cannot be canceled, reduced in amount or coverage eliminated in less than fifteen (15) days after mailing written notice to the insured and/or the Owner of such alteration or cancellation, sent by registered mail.

F. The Contractor shall furnish the Owner with satisfactory proof of carriage of the insurance required before the Owner grants written approval.

7. REQUESTS FOR PAYMENT

A. All requests for payment must be submitted to Facilities Administration at the address listed in item (F) below.

B. All requests for payment may be submitted on the "AIA APPLICATION FOR PAYMENT AND CERTIFICATE FOR PAYMENT" AIA DOCUMENT G702 and G703 or company invoice.

C. All requests for payment must contain a completed form "APPENDIX E – MBE DOCUMENTATION FOR CONTRACT PAYMENTS" (p. MBE-1).

D. No partial payment will be made unless agreed to in advance. Final payment will be made lump sum within forty-five (45) consecutive days after acceptance of the work (refer to Specifications, Division I, section 01700 "Contract Closeout" p.DIV01-3) and the submission both of notarized contractor's affidavit and four copies of invoices which are to include the contract, account and job order numbers.

E. The Contractor's affidavit shall state:

- "This is to certify that all costs of materials, equipment, labor, and all else entering into the accomplishment of this contract, including payrolls, have been paid in full."

F. Executed contract documents, insurance certifications and, upon completion and acceptance of the work, applications for payment, invoices and other information requested are to be sent to:

University of North Carolina at Wilmington
Office of Facilities – 5910
601 South College Road
Wilmington, North Carolina 28403-5910

- *It is imperative that contract documents, invoices, etc., be sent only to the above address in order to assure proper and timely delivery and handling.*

8. PROJECT SITE CLEANING UP

The Contractor shall keep the sites and surrounding area reasonable free from rubbish at all times and shall remove debris from the site from time to time or when directed to do so by the Owner. Before final inspection and acceptance of the project, the Contractor shall thoroughly clean the sites, and completely prepare the project and site for use by the Owner. The contractor shall provide trash containers for removal of rubbish generated by the work. Contractors shall not use the university's refuse containers.

9. GUARANTEE

A. 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 Contractor shall replace such defective equipment or materials, without cost to the Owner, within the manufacturer's warranty period.

B. The Contractor 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 final acceptance of the work and shall replace such defective materials or workmanship without cost to the Owner.

C. Additionally, the Contractor shall guarantee materials and workmanship against latent defects arising from faulty materials, faulty workmanship or negligence which is hidden or not readily apparent to the Owner at the time of final acceptance and which is discovered by the Owner within six (6) years following final acceptance of the work. The guarantee for latent defects related to any structural system shall be ten (10) years. The Contractor shall replace such defective materials or workmanship without cost to the Owner.

10. CONTRACTOR-SUBCONTRACTOR RELATIONSHIPS

The Contractor agrees that the terms of these contract documents shall apply equally to a subcontractor as to the Contractor, and that the subcontractor is bound by those terms as an employee of the Contractor.

END OF GENERAL CONDITIONS

UNIVERSITY OF NORTH CAROLINA AT WILMINGTON

SUPPLEMENTARY GENERAL CONDITIONS

GENERAL INSTRUCTIONS

The following supplements modify, expand certain portions of, or provide additional or more specific information or instructions to requirements of the General Conditions of the Informal Bid Contract, published by North Carolina Department of Administration, State Construction Office. In case of conflict or discrepancy, the more restrictive requirements shall govern except when specifically modified or rescinded by direct reference or instructions.

1. DRAWINGS

The bound set of Graphical Documents, identified in the following Schedule of Drawings listed a the TOC.

2. SCHEDULE

The Contractor shall commence work as soon as possible after Notice to Proceed is issued or as specified in the contract documents. The time stated in the contract shall include all time necessary for final cleanup. The Contractor shall furnish the Owner a job schedule within five (5) working days of the contract award. Work performed in the execution of this contract shall be a continuous and uninterrupted progression of work unless specifically stated otherwise in the contract or approved in writing by the Owner. The schedule must be strictly adhered to. Contingency plans for having properly trained workers and supervision must be in place. Work may begin August 18, 2020. Project must be complete and ready for use by close of business December 4, 2020.

3. EXISTING CONDITIONS

The Contractor, in submitting a proposal and executing a contract, acknowledges that he has completely investigated all existing facilities and job site conditions, including those of a subsurface nature, and clearly understands the intent and requirements of the contract documents. Failure to inspect the site or contract documents prior to bidding will not relieve the Contractor of the responsibility to perform all work included in this contract.

4. LICENSE REQUIRED

A current Contractor Board Registered Contractor License is required for this project. The Contractor License number shall be included on the “Execution of Bid” document where applicable.

5. PRE-CONSTRUCTION CONFERENCE

There will be a Pre-Construction Conference for this project to be scheduled by the Project Manager with the successful bidder after “Notice to Proceed” has been issued.

6. CONSTRUCTION STAKEOUT

The Contractor is responsible for locating the plantings on the drawings at the locations shown in the field. Any stakes, layout, and measurements required to perform the work described in the specifications and accompanying plans will be the responsibility of the Contractor.

7. COPIES OF DRAWINGS AND SPECIFICATIONS

The Owner shall furnish the Contractor free of charge copies of plans and specifications as follows:

A. Contractor - Up to three (3) sets of the drawings described in the Schedule of Drawings and three (3) complete sets of the specifications.

B. Other Contractors - No additional drawings and specifications shall be provided for the use of any other contractor.

8. USE OF PREMISES

A. SITE RESTRICTIONS - The Contractor shall ensure uninterrupted access and public safety in the area of the job site. The Contractor shall conduct his operations in strict compliance with regulations, policies and operating procedures established by the University.

B. SECURITY RESTRICTIONS - The Contractor shall follow directions set forth by the University Police and Safety Personnel.

9. CLAIMS FOR DELAYS OR ADDITIONAL COST

No claims for delays or additional costs by any Contractor shall be considered due to restrictions of operations or limitations of schedule or of hours of operation as required by the terms of the Contract.

10. CUTTING, PATCHING AND DIGGING:

A. PREVENTING DAMAGE - The Contractor shall exercise every precaution to prevent damage or alteration of any existing material, detail, finish or other site feature scheduled to remain during the performance of the work. Any cost for additional patching and repair due to incorrect, excessive or careless cutting, demolition or other related damages as determined by the Owner, shall be paid by the Contractor.

B. OWNER'S AUTHORITY TO SUSPEND OPERATIONS - The Owner shall have authority to limit or suspend any operations which, in their opinion, may threaten the integrity of any existing structures, systems, finishes or details, or which compromise public health or safety. The Contractor shall comply immediately with any directive issued by the Owner, which relates to safety issues or the protection of existing features without the requirement for advance written notice.

C. DIGGING PROCEDURES - See Section 11-F of the Supplementary General Conditions for instructions relating to required digging procedures. All trenches, **holes dug will be tamped back and sod grass of like kind placed in these areas. The level of the sod should match adjacent elevations. Contractor will correct any settling of these areas for a period of 12 months. A complex** drain system exists on these fields. Contractor shall make all effort to not cut this system, but in the event of a cut will repair the drain system at no additional costs to the owner.

D. NCOSHA STANDARDS COMPLIANCE - The Contractor is responsible for following pertinent NCOSHA safety standards during the completion of this Contract, including compliance with regulation pertaining to any digging/trenching operations.

11. UTILITIES

A. UTILITY CHARGES and CONNECTIONS - No service or connection charges or fees by serving utility companies are anticipated in connection with the Project Work. In the event such charges are levied by any serving utility, the Owner shall reimburse the Contractor for utility service and/or connection charges at direct invoice from the billing Utility Company, after certification of the invoice by the Owner.

B. COORDINATION AND SCHEDULING OF UTILITY WORK - Coordination and scheduling of work to be performed by serving utilities, if required for relocation or temporary disconnection, shall be the responsibility of the Contractor whose work requires such adjustments.

C. AVAILABILITY OF UTILITIES TO CONTRACTOR - The Owner shall make existing power and water for construction operations available to the Contractor. Contractor shall make connections to service junctures in compliance with applicable codes at his expense. The point of any utility connection shall be established by the Owner before the commencement of any connection activity. The Contractor shall restore all utilities to their original state prior to final inspection.

D. SPECIAL REQUIREMENTS - The existing Utilities Services (Power, Telephone, Water, and Sanitary) and all connections and branch circuits shall be maintained in continuous operation during the course of the

project construction except for required modifications. A minimum of a 48-hour advance written notice to the Owner from the Contractor shall be required prior to the commencement of any critical interruption that has been approved in writing by the Owner.

E. UNDERGROUND UTILITIES - Buried telephone lines and cables, high voltage electrical power cables, water and gas mains, sanitary sewer mains and storm water drains may be encountered during excavation activities. The Contractor must anticipate this possibility and make every effort to avoid damage to underground utilities.

F. DIGGING PROCEDURES

a. UNCW DIGGING PERMIT - A **UNCW Digging Permit** must be obtained from the University Physical Plant Division by the Contractor immediately after the Contract Award and prior to the commencement of any digging/trenching activity relating to the project.

b. NOTIFICATION - The Contractor shall notify the Owner three (3) days prior to any digging/trenching operations to schedule the locating and marking of existing underground utilities by the Owner. The Owner will attempt to determine exact utility locations within the three (3) day period. Under no circumstances shall any digging/trenching operations occur before the marking of buried utility locations by the Owner. Under no circumstance is any utility work, such as connections or disconnections, to be performed by the Contractor without a three (3) day prior notification to the Owner.

c. *North Carolina 811 underground utility location service* ***NOTIFICATION - The Contractor shall be responsible for contacting, arranging and coordinating the location of any additional buried utilities with*** *North Carolina 811 underground* ***utility location service****.*

d. RE-NOTIFICATION - Should weather or other site conditions render the utility location markings undistinguishable, it will be the Contractor's responsibility to re-contact the parties described above and have the utility location relocated and re-marked giving the same three (3) day prior notification to the Owner.

e. LOCATION OF UTILITIES – ***The Contractor shall locate all marked underground utilities by hand digging prior to the beginning of any digging/trenching operations.***

f. REPAIR OR DAMAGE COST - The Contractor shall be responsible for any cost relating to the repair of damaged utilities caused by the Contractor or their agents.

12. OWNER INSPECTIONS:

A. DURING CONSTRUCTION – The Owner reserves the right to provide full time or part time inspection during construction to verify that plans and specifications are being met as the work progresses. The Owner shall resolve conflicts arising from interpretations of the plans and/or specifications and their decision shall be binding. Inspection by the Owner does not relieve the Contractor of their responsibility to meet the requirements of plans and specification nor to provide any quality control that may be required.

B. FINAL INSPECTION/PROJECT COMPLETION – Upon completion of the project, a "Final" inspection will be performed by the Owner and the Contractor's representative for acceptance of the Contractor's work. At that time, a punch list will be prepared and a copy provided to the Contractor. Upon completion of all work, including the punch list items, the project will be authorized for payment by the Owner.

13. SAMPLES AND TESTING:

A. All material and aggregate samples shall be provided by the Contractor at his expense and shall be approved by the Owner prior to their use on the job. Additional samples of materials may be requested by the Owner during construction and shall be provided by the Contractor at no expense to the Owner.

B. Tests to determine conformance with the specified requirements may be required by the Owner and will be performed by an independent testing laboratory, arranged and paid for by the Owner. If repeated tests are required due to the Contractor's failure to meet specifications, the Owner will arrange all subsequent tests of the same portion of work, with all associated cost being paid for by the Contractor.

14. SANITARY FACILITIES

A. Temporary sanitary convenience for the use of employees on the job site shall be provided and maintained in a timely manner by the Contractor and removed upon completion of the work. The Contractor is only to use conveniences approved by health authorities.

B. Contractor employees are not permitted to use any existing sanitary facilities located on the University.

15. ADDITIONAL CLEANING UP RESPONSIBILITIES

A. DAILY CLEANUP - The entire work site shall be placed in an orderly manner at the end of each workday, including the proper placement of any safety barriers, by the Contractor prior to their leaving the site.

B. WASTE REMOVAL/DUMP SITES – Contractor shall make all necessary provisions for removal and legal disposal of debris created by his operations from the site. No dumpsite is available on the campus. Contractor shall include all fees for disposal of all waste in their bid price.

C. WASH DOWNS – Any paved surfaces including walkways, bikeways, streets, etc. shall be washed down by the Contractor and any evidence of construction activity removed prior to final inspection.

D. CLEAN UP PERIOD – The Contractor must comply with this section for the entire construction period.

E. Absolutely no cleaning of brushes or disposal of paint shall be allowed on the grounds of UNCW. Contractor shall coordinate with project manager for approved brush washing areas.

16. ADDITIONAL SAFETY REQUIREMENTS

A. UNCW CONFINED SPACE ENTRY PERMIT - A **UNCW Confined Space Entry Permit** must be obtained from the University Environmental Health and Safety Division by the Contractor immediately after the Contract Award and prior to the commencement of any confined space activity relating to the project.

B. UNCW ASBESTOS ABATEMENT PERMIT – A **UNCW Asbestos Abatement Permit** must be obtained from the University Environmental Health and Safety Division by the Contractor immediately after the Contract Award and prior to the commencement of any asbestos abatement activity relating to the project.

C. SMOKING – Smoking is prohibited in all UNCW buildings. Smoking is allowed in designated areas only,

END OF SUPPLEMENTARY GENERAL CONDITIONS

UNIVERSITY OF NORTH CAROLINA AT WILMINGTON

FORM OF PROPOSAL

PROPOSAL FOR: SINGLE PRIME GENERAL CONTRACT

PROJECT: **Tri-House HVAC and Central Plant Improvements**
UNCW, Wilmington, North Carolina

SUBMITTED TO: Office of Project Management
University of North Carolina at Wilmington
601 South College Road
Wilmington NC 28403-5620

SUBMITTED BY: Bidder's Name: _____

Address: _____

License Classification: _____ License Number: _____

In compliance with your request for proposals, the undersigned as Bidder hereby proposes to furnish all labor and materials, equipment, operations and incidentals, and to perform all work for the complete execution of the construction entering into the Single Prime Contract for the UNCW Tri-House HVAC and Central Plant Improvements project at the University of North Carolina at Wilmington, in strict accordance with plans, specifications, contract documents, codes and regulations to the full and entire satisfaction of the Owner for the consideration of the following amount:

GENERAL CONTRACT: *(Fill in appropriate amounts)*

LUMP SUM BASE BID: _____ Dollars ($_____)

ALTERNATES: Should any of the alternates as described in the contract documents be accepted, the amount written below shall be the amount to be "added to" the base bid.

ALTERNATE 1:

ALTERNATE 1 BID: _____ Dollars ($_____)

ALTERNATE 2:

ALTERNATE 2 BID: _____ Dollars ($_____)

ALTERNATE 3:

ALTERNATE 3 BID: _____ Dollars ($_____)

ALTERNATE 4:

ALTERNATE 4 BID: _____ Dollars ($_____)

TIME OF COMPLETION: Notice to proceed is expected to be issued by August 11, 2020. Work shall commence on August 18, 2020 and must be completed no later than the close of business on December 4, 2020.

UNIVERSITY OF NORTH CAROLINA AT WILMINGTON

FORM OF PROPOSAL

The Undersigned, as Bidder, hereby declares that the only person or persons interested in this proposal, as principal or principals, is or are named herein, and that no other party or parties than those herein mentioned have any interest in this proposal or in the contract which may be entered into as a result of acceptance of this proposal; and that this proposal is made without connection with any person, company, corporation or parties making a bid or proposal; and that this proposal is in all respects fair and in good faith without collusion or fraud.

The Bidder further declares that he has examined the Site of the Work and informed himself fully with all conditions pertaining to the place where the Work is to be performed; that he has examined the Drawings, Specifications and Instructions for the Work and the Contract Documents relative thereto, and has read all special provisions furnished prior to the Opening of Bids; and that he fully understands and has made every provision to operate under the conditions relative to the Work required by the Contract Documents.

The undersigned further states that he is a duly Licensed Building Contractor in the State of North Carolina under applicable statutes governing his trade, and that all fees, licenses, permits, and charges pertinent to the submission of this Bid have been paid in full.

The undersigned hereby designates the following as his legal address to which such notice of acceptance may be delivered.

_____

_____

_____

_____

UNIVERSITY OF NORTH CAROLINA AT WILMINGTON

FORM OF PROPOSAL

The Bidder further proposes and agrees hereby to commence work under his Contract on a date to be specified by the Owner and to fully complete all work required by the Contract specified time frame.

In submitting this bid, it is understood that the Owner reserves the unqualified right to reject any and all proposals.

Respectfully submitted this _____ day of _____, 2016

_____
Firm or Corporation Making Bid:

By:_____
Print Name

_____
Signature

Title: _____
(Owner, Partner or Corporation President or Vice-President Only)

_____

_____
Address:

_____ _____
Telephone Number Fax Number

_____
E-mail Address:

_____
Contractor Classification:

_____
Contractor License Number:

_____
Contractor Federal Tax Identification Number:
(Corporate Seal)

UNIVERSITY OF NORTH CAROLINA AT WILMINGTON

FORM OF PROPOSAL

The Bidder declares that he has received, reviewed and complied with all instructions issued in the following addenda:

Addenda Received and Considered in Preparing the Bid.
(Initial as appropriate)

Addendum No. 1	Rec'd Date _____	Print Name _____
		Signature _____
Addendum No. 2	Rec'd Date _____	Print Name _____
		Signature _____
Addendum No. 3	Rec'd Date _____	Print Name _____
		Signature _____
Addendum No. 4	Rec'd Date _____	Print Name _____
		Signature _____
Addendum No. 5	Rec'd Date _____	Print Name _____
		Signature _____
Addendum No. 6	Rec'd Date _____	Print Name _____
		Signature _____
Addendum No. 7	Rec'd Date _____	Print Name _____
		Signature _____

List of Sub-Contractors/Vendors proposed to be used for the Project; include their appropriate license/registration numbers if applicable:
(Mark N/A if not applicable)

Subcontractor/Vendor	License/Registration
_____	_____
_____	_____
_____	_____

END OF FORM OF PROPOSAL

UNIVERSITY OF NORTH CAROLINA AT WILMINGTON

FORM OF PROPOSAL

Informal Construction Minority Participation (updated 1/4/2017)

Failure to properly complete and attach to bid may result in rejection of bid.

Fill out section A. (Required) This section refers to your company.

A. UNCW is committed to increase HUB (Historically Underutilized Businesses) vendor participation. Please check the appropriate information below to properly identify your company. (51% owned **and** controlled by the following.)

- ☐ **(B)** Black, African American
- ☐ **(H)** Hispanic
- ☐ **(A)** Asian American
- ☐ **(I)** American Indian
- ☐ **(DIS)** Disabled Owned
- ☐ **(F)** Female Owned - non-minority
- ☐ **(DBE)** Socially & Economically Disadvantaged - *as defined in 15 U.S.C. 637*
- ☐ None of the above

Fill out section B or C. (Required) These sections refer to your use of HUB subcontractors.

B. ***Identification of Minority Business Participation "N/A" is not acceptable – You must complete Section C***

I, _____, do hereby certify that on this project, we will use the following minority business enterprises as construction subcontractors, vendors, suppliers or providers of professional services. *(Use additional sheet if necessary)*

PROVIDE all information Name, Address and Phone #	*** Minority Category**	**Work Description**	**Dollar Value**
1.			
2.			
3.			
4.			

Minority Categories:** Black, African American **(B)**, Hispanic **(H)**, Asian American **(A)**, American Indian **(I)**, Persons with Disabilities **(DIS)**, Female Owned **(F)**, and Socially and Economically Disadvantaged Business Enterprise **(DBE)

The total value of minority business contracting will be ($) _____which equals _____%

C. ***Intent to Perform Contract with Own Workforce and/or all NON-MINORITY subcontractors.***

I, _____, do hereby certify that it is our intent to perform 100% of the work **required for this project or I am using all NON-MINORITY subcontractors**.

Additionally, where applicable**,** the Bidder states that the Bidder, 1) does not customarily subcontract elements of this type project, 2) normally performs and has the capability to perform, and 3) will perform all elements of the work on this project with his/her own current work forces. The Bidder agrees to provide any additional information or documentation requested by the owner in support of the above statement.

UNIVERSITY OF NORTH CAROLINA AT WILMINGTON

FORM OF PROPOSAL

MBE DOCUMENTATION FOR CONTRACT PAYMENTS

Prime Contractor/Architect: _____

Address & Phone: _____

Project Name: _____

Pay Application #: _____ Period: _____

Contract #: _____

The following is a list of payments to be made to minority business contractors on this project for the above-mentioned period.

Firm Name	***Minority Category**	**Payment Amount**	**Owner Use Only**

*Minority categories: Black, African American (**B**), Hispanic (**H**), Asian American(**A**), American Indian (**I**), Female (**F**), Socially and Economically Disadvantaged (**D**)

Date: _____ Approved/Certified By: _____

Name

_____

Title

_____

Signature

** THIS DOCUMENT MUST BE SUBMITTED WITH EACH PAY REQUEST & FINAL PAYMENT**

UNIVERSITY OF NORTH CAROLINA AT WILMINGTON

FORM OF PROPOSAL

DIVISION I - GENERAL REQUIREMENTS

01010 SUMMARY

The Contractor shall provide each item, in all sections of these specifications, of quality, or subject to qualifications as noted, or Owner approved equal. Unless noted “By Others” the Contractor shall perform each operation described according to conditions stated, providing all the necessary supervision, labor, equipment, plant, services, and materials (except for those specifically identified as “Furnished By Owner”) for all construction specified herein and shown on accompanying drawings to provide a complete and usable facility except as specifically noted.

01015 INSPECTION OF PREMISES

A. The Contractor shall visit and examine the site and respective building to have a complete understanding of all existing conditions relating to the work prior to submitting his bid.

B. The Owner reserves the right to full or part time inspection of the work by his agents and as delineated elsewhere in these specifications and other contract documents.

01040 COORDINATION AND SUPERVISION

The Contractor shall provide, as a part of the base contract bid, a full time designated superintendent skilled in the construction trades and project management to direct all work, coordinate subcontractors and with other Contractors, expedite materials, perform inspections, ensure the quality execution of all the requirements of these specifications and to coordinate with the Owner.

01330 SUBMITTAL PROCEDURES

The Contractor shall provide to the Owner Shop Drawings, Product Data and Samples as requested.

01400 QUALITY CONTROL

A. The Contractor shall provide all the supervision, technical assistance and other quality controls necessary to ensure the proper execution of all phases of this project as specified and in accordance with the best practices of the trades.

B. The Owner reserves the right to full or part time inspection of the work by his agents. If in the process of his inspection, work is determined to be of poor or substandard workmanship, or not in compliance with the drawings and/or specifications, the Owner reserves the right to stop all work at no additional cost until corrective action is taken by the Contractor to bring the work into compliance. Poor or substandard workmanship will not be accepted by the Owner. The Owner's inspections do not relieve the Contractor, in part or whole, of his responsibility to execute the work as specified. All changes to the contract shall be in writing.

01600 MATERIAL AND EQUIPMENT

The Contractor shall be responsible for the procurement, shipment, delivery, unloading, acceptance, storage, security and protection of all materials and equipment required to accomplish the project including all items provided by the Owner.

01700 CONTRACT CLOSEOUT

UNIVERSITY OF NORTH CAROLINA AT WILMINGTON

FORM OF PROPOSAL

Upon completion of the project, a "Final" inspection will be performed jointly by the Owner and the Contractor for acceptance of the Contractor's work. At that time a punch list will be prepared and a copy provided to the **Contractor. If applicable to the project, copies of all DOI inspection reports, O&M manuals, system training and testing are required before final payment can be issued. Upon completion of all work, including the punch list items, the project will be authorized for payment by the Owner**.

END OF DIVISION

** (c) Each bidder, which shall mean first-tier subcontractor for construction manager at risk projects for purposes of this subsection, on a project bid under any of the methods authorized under G.S. 143-128(a1) shall identify on its bid the minority businesses that it will use on the project and an affidavit listing the good faith efforts it has made pursuant to subsection (f) of this section and the total dollar value of the bid that will be performed by the minority businesses. A contractor, including a first-tier subcontractor on a construction manager at risk project that performs all of the work under a contract with its own workforce may submit an affidavit to that effect in lieu of the affidavit otherwise required under this subsection. The apparent lowest responsible, responsive bidder shall also file the following:

(1) Within the time specified in the bid documents, either:

a. An affidavit that includes a description of the portion of work to be executed by minority businesses, expressed as a percentage of the total contract price, which is equal to or more than the applicable goal. An affidavit under this sub-subdivision shall give rise to a presumption that the bidder has made the required good faith or effort; or

b. Documentation of its good faith effort to meet the goal. The documentation must include evidence of all good faith efforts that were implemented, including any advertisements, solicitations, and evidence of other specific actions demonstrating recruitment and selection of minority businesses for participation in the contract.

(2) Within 30 days after award of the contract, a list of all identified subcontractors that the contractor will use on the project.

Failure to file a required affidavit or documentation that demonstrates that the contractor made the required good faith effort is grounds for rejection of the bid.

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 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. Upgrading DDC system within and surrounding the Central Plant building.
2. Replace cooling towers fan motors.
3. Upgrade heating water plant.
4. 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. Design layout shown on drawings is based on physical sizes of reputable equipment manufacturers. If equipment other than 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. Owner/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.

G. Where seismic design for supports is required, submit installation details for supports and engineering analysis as specified.

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 be required for compliance with codes, standards and regulations, whether specifically mentioned in these specifications or shown on the drawings.

C. Obtain 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. 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 Owner/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 Owner/Engineer. No extras will be allowed for rework of uncoordinated installations.

D. Determine 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 manufacturer's directions completely in the delivery, storage, protection and installation of all equipment and materials. Notify the Owner/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 Owner/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 at no additional cost.

1.6 OPERATION AND MAINTENANCE MANUALS

A. Refer to individual mechanical sections and Division 1.

1.7 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 Owner/Engineer at no additional cost.

1.8 SUPERVISION

A. Contractor to 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 Owner/Engineer, Owner, and local inspection authorities will make inspections during the progress of the work. Contractor to accommodate such inspections and correct deficiencies noted.

1.9 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 Owner/Engineer.

1.10 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.

1.11 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 Owner/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 patched surface to its original appearance at completion of patching.

H. Where waterproofed surfaces are patched, maintain integrity of waterproofing.

I. Remove rubble and excess patching materials from the premises.

1.12 INTERPRETATION OF DRAWINGS

A. Drawings and specifications under this Division are complementary each to the 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 the drawings or specifications are unintentional. Contractor is responsible for notifying the Owner/Engineer of 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.

1.13 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.

1.14 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 Division 23 shall comply with Division 26 specification requirements. Install control wiring in conduit.

C. See Division 26 specifications and electrical connection diagrams for division of labor between Divisions 23 and 26.

D. 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.

1.15 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.

1.16 ALTERNATE BIDS

A. Alternate Bids, IF ANY, are described in relevant sections of the General and Supplemental General Conditions and Division 1 Specification Sections.

1.17 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.

1.18 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.

1.19 PROJECT CLOSEOUT

A. Submit under 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

SECTION 230010 – EXISTING 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 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 Owner/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 Owner/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 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.

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 Owner/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 Owner/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 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general requirements for polyphase, squirrel-cage induction motors for use on both existing cooling tower fans and shipped separately by equipment manufacturer for field installation.

1.2 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 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. 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.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: 1.25.

D. Rotor: Random-wound, squirrel cage.

E. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

F. Temperature Rise: Match insulation rating.

G. Insulation: Class F.

H. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code G.

I. Enclosure Material: Cast iron for motor frame.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

A. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. 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.
2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Liquid-in-glass thermometers.
2. Thermowells.
3. Dial-type pressure gages.
4. Gage attachments.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Standard: ASME B40.200.
2. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.
3. Case Form: Adjustable angle unless otherwise indicated.
4. Tube: Glass with magnifying lens and blue or red organic liquid.
5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
6. Window: Glass.
7. Stem: Aluminum and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

8. Connector: 1-1/4 inches, with ASME B1.1 screw thread.

9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.
3. Material for Use with Steel Piping: CRES.
4. Type: Stepped shank unless straight or tapered shank is indicated.
5. External Threads: NPS 3/4 ASME B1.20.1 pipe threads.
6. Internal Threads: 1/2, with ASME B1.1 screw thread.
7. Bore: Diameter required to match thermometer bulb or stem.
8. Insertion Length: Length required to match thermometer bulb or stem.
9. Lagging Extension: Include on thermowells for insulated piping and tubing.
10. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.3 DIAL-TYPE PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Standard: ASME B40.100.
2. Case: Cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. 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.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Metal.
10. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending a minimum of 2 inches 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 direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

G. Install valve and snubber in piping for each pressure gage for fluids.

H. Install test plugs in piping tees.

I. Install flow indicators in piping systems in accessible positions for easy viewing.

J. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

K. Install connection fittings in accessible locations for attachment to portable indicators.

L. Install thermometers in the following locations:

1. Inlet and outlet of each hydronic boiler.
2. Heating Water Supply Piping to dormitories.

M. Install pressure gages in the following locations:

1. Suction and discharge of each pump.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow space for service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

A. Thermometers shall be the following:

1. Industrial-style, liquid-in-glass type.

B. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Heating, Hot-Water Piping: 0 to 250 deg F.

3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages shall be direct-mounted, metal-case, dial-type.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi.

END OF SECTION 230519

SECTION 230523.13 - BUTTERFLY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. High-performance butterfly valves.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve.

PART 2 - PRODUCTS

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.1 for flanges on iron valves.
2. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
3. ASME B31.1 for power piping valves.
4. ASME B31.9 for building services piping valves.

C. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

D. Valve Sizes: Same as upstream piping unless otherwise indicated.

E. Valve Actuator Types:

1. Gear Actuator: For valves NPS 8 and larger.
2. Handlever: For valves NPS 6 and smaller.

F. Valves in Insulated Piping: With 2-inch stem extensions with extended necks.

2.2 HIGH-PERFORMANCE BUTTERFLY VALVES

A. Single-Flange, High-Performance Butterfly Valves, Class 150:

1. Description:

a. Standard: MSS SP-68.
b. CWP Rating: 285 psig at 100 deg F.

c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: Carbon steel, cast iron, ductile iron, or stainless steel.
e. Seat: Reinforced PTFE or metal.
f. Stem: Stainless steel; offset from seat plane.
g. Disc: Carbon steel.
h. Service: Bidirectional.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

3.2 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.

3.3 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger:

1. High-Performance Butterfly Valves: Single flange, Class 150.

END OF SECTION 230523.13

SECTION 230523.14 - CHECK VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Iron swing check valves.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.1 for flanges on iron valves.
2. ASME B31.9 for building services piping valves.

C. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

D. Valve Sizes: Same as upstream piping unless otherwise indicated.

E. Valve Bypass and Drain Connections: MSS SP-45.

2.2 IRON SWING CHECK VALVES

A. Iron Swing Check Valves with Metal Seats, Class 125:

1. Description:

a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.

g. Gasket: Asbestos free.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install swing check valves for proper direction of flow in horizontal position with hinge pin level.

3.2 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.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Pump-Discharge Check Valves:

a. Iron swing check valves with lever and weight or with spring; metal or resilient-seat check valves.

B. 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.

C. Select valves, except wafer types, with the following end connections:

1. For Steel Piping: Flanged ends.

3.4 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger:

1. Iron swing check valves with metal seats, Class 125.

END OF SECTION 230523.14

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Thermal-hanger shield inserts.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated, or epoxy powder-coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.2 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Hot Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100-psi, ASTM C552, Type II cellular glass with 100-psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength.

B. For Clevis Hangers: Insert and shield shall cover lower 180 degrees of pipe.

C. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.3 MATERIALS

A. Carbon Steel: ASTM A1011/A1011M.

PART 3 - EXECUTION

3.1 APPLICATION

A. 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.

3.2 HANGER AND SUPPORT INSTALLATION

A. 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.

B. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

C. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

D. Install hangers and supports to allow controlled thermal 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.

E. Install lateral bracing with pipe hangers and supports to prevent swaying.

F. Install building attachments attached 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.

G. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

H. 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.

I. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. 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.

3. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.

b. NPS 4: 12 inches long and 0.06 inch thick.
c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.

4. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

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 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

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 hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use carbon-steel pipe hangers and supports and attachments for general service applications.

E. Use thermal-hanger shield inserts for insulated piping.

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. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

H. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
4. C-Clamps (MSS Type 23): For structural shapes.
5. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
6. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
7. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

I. 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.

END OF SECTION 230529

SECTION 230548.13 - VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads.

1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
2. Size: Factory or field cut to match requirements of supported equipment.
3. Minimum deflection as indicated on Drawings.
4. Pad Material: Oil- and water-resistant rubber.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Strength of Support Assemblies: Where not indicated, select sizes of components so strength is adequate to carry static and wind force loads within specified loading limits.

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Stencils.
3. Valve tags.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

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, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. 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. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. 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 STENCILS

A. Stencils for Piping:

1. Lettering Size: Size letters according to ASME A13.1 for piping.
2. Stencil Material: Fiberboard or metal.

3. Stencil Paint: Exterior, gloss, alkyd enamel. Paint may be in pressurized spray-can form.

B. Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to 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: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link chain or S-hook.

B. Valve Schedules: Update the existing valve schedule if available, otherwise provide new for new work. 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. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surface of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Pipe Stencil 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. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations and on both sides of through walls.
4. At access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 25 feet along each run.

B. Pipe Color Schedule:

1. Heating Water Piping: Black letters on a safety-orange background.
2. Natural Gas: Black letters on a safety-yellow background.

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:
   a. Hot Water: 1-1/2 inches, round.
   b. Gas: 1-1/2 inches, round.

2. Valve-Tag Colors: Match existing

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 Hydronic Piping Systems:

a. Constant-flow hydronic systems.

2. Testing, adjusting, and balancing of equipment.
3. HVAC-control system verification.

1.2 DEFINITIONS

Retain definition(s) remaining after this Section has been edited.

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

F. TDH: Total dynamic head.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 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 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.

C. Strategies and Procedures Plan: Within 30 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 30 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.

1.4 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. TAB Specialists Qualifications, Certified by NEBB or TABB:

1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.
2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB.

1.5 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. 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 equipment performance data, including 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.

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 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.

I. 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.

J. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.

K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

L. Examine system pumps to ensure absence of entrained air in the suction piping.

M. Examine operating safety interlocks and controls on HVAC equipment.

N. 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. 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" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

B. Mark equipment and balancing devices, including damper-control positions, valve position indicators, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

C. Take and report testing and balancing measurements in inch-pound (IP) and metric (SI) 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. Hot-water boilers.

3.5 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.

3.6 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.

3.7 PROCEDURES FOR MOTORS

A. 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.

3.8 PROCEDURES FOR COOLING TOWERS

A. Open-Circuit Cooling Towers: Measure and record the following data:

1. Fan, motor, and motor controller operating data.

3.9 PROCEDURES FOR BOILERS

A. Hydronic Boilers:

1. Measure and record entering- and leaving-water temperatures.
2. Measure and record water flow.
3. Measure and record pressure drop.
4. 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 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 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 or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.11 TOLERANCES

A. Set HVAC system's water flow rates within the following tolerances:

1. Heating-Water Flow Rate: Plus or minus 5 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

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 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. Engineer's name and address.
6. Contractor's name and address.
7. Report date.
8. Signature of TAB supervisor who certifies the report.
9. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
10. 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.

11. Nomenclature sheets for each item of equipment.
12. Notes to explain why certain final data in the body of reports vary from indicated values.
13. 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 hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Water flow rates.
2. Pipe and valve sizes and locations.

E. 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.

F. 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 Owner.

B. Owner shall randomly select measurements, documented in the final report, to be rechecked.

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 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.

E. 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 230593

SECTION 230716 - HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating HVAC equipment that is not factory insulated.

B. Related Sections:

1. Section 230719 "HVAC Piping Insulation."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Material test reports.

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.

1.5 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 equipment Installer for equipment insulation application.

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.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

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 and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Mineral-Fiber Board: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB. Provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

F. Mineral-Fiber, Pipe and Tank: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C1393.

1. Semirigid board material with factory-applied [ASJ] [FSK] jacket.
2. Nominal density is 2.5 lb/cu. ft. or more.
3. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less.
4. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

C. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

D. PVC Jacket Adhesive: Compatible with PVC jacket.

2.4 MASTICS AND COATINGS

A. Materials shall be compatible with insulation materials, jackets, and substrates.

B. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
2. Service Temperature Range: 0 to plus 180 deg F.
3. Color: White.

2.5 SEALANTS

A. Materials shall be as recommended by the insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.

B. ASJ Flashing Sealants, and Vinyl, PVDC, and 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.

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall 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: Color-code jackets based on system.
3. Factory-fabricated tank heads and tank side panels.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
1. Width: 3 inches.
2. Thickness: 11.5 mils.

3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. 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.

PART 3 - EXECUTION

3.1 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:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range of between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

B. Install insulation materials, forms, vapor barriers or retarders, and jackets, of thicknesses required for each item of equipment, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

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 storage, application, and finishing. Replace insulation materials that get wet.

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 attached 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.
4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

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.
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 o.c.
4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.

L. Cut insulation in a manner to avoid compressing insulation more than 25 percent of its nominal thickness.

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 in similar fashion to butt joints.

O. 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. Manholes.

5. Handholes.
6. Cleanouts.

3.3 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive, anchor pins, and speed washers.

1. Apply adhesives in accordance with manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
    d. Do not over-compress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins, and attach speed washers.
    g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation end around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch-diameter fasteners with wing nuts. Alternatively, secure the box sections together using a field-adjustable latching mechanism.
2. Fabricate boxes from stainless steel, at least 0.050 inch thick.

3.4 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. 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.

3.5 FINISHES

A. Equipment Insulation with ASJ: Paint jacket with paint system identified in 230553 – “Identification for HVAC Piping and Equipment."

3.6 FIELD QUALITY CONTROL

A. Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections: Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location for each type of equipment. For large equipment, remove only a portion adequate to determine compliance.

C. All insulation applications will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.7 EQUIPMENT INSULATION SCHEDULE, GENERAL

A. Insulation conductivity and thickness per pipe size shall comply with schedules in this Section or with requirements of authorities having jurisdiction, whichever is more stringent.

B. Acceptable 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 is Contractor's option.

3.8 INDOOR EQUIPMENT INSULATION SCHEDULE

A. Insulate indoor equipment that is not factory insulated.

B. Heating-hot-water pump insulation shall be the following:

1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

C. Heating-hot-water expansion/compression tank insulation shall be the following:

1. Mineral-Fiber Pipe and Tank: 1 inch thick.

D. Heating-hot-water air/dirt-separator insulation shall be the following:

1. Mineral-Fiber Pipe and Tank: 2 inches thick.

3.9 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. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces of up to 72 Inches:

1. PVC, Color-Coded by System: 20 mils thick.

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulation for HVAC piping systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Material test reports.

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. 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 and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.5 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. 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. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Mineral-Fiber, Preformed Pipe: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547.

1. Preformed Pipe Insulation: Type I, Grade A with factory-applied ASJ.
2. 850 deg F.
3. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
4. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

C. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.

2.3 MASTICS AND COATINGS

A. Materials shall be compatible with insulation materials, jackets, and substrates.

B. Breather Mastic: Water based; suitable for indoor use on above-ambient services.

1. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
2. Service Temperature Range: 0 to plus 180 deg F.
3. Color: White.

2.4 SEALANTS

A. Materials shall be as recommended by the insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.

B. ASJ 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 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.

2.6 FIELD-APPLIED JACKETS

A. Field-applied jackets shall match existing.

2.7 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

2.8 SECUREMENTS

A. Bands: Stainless Steel, ASTM A240/A240M, Type 304; 0.015-inch-thick, 1/2-inch-wide with wing seal or closed seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

PART 3 - EXECUTION

3.1 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:

1. Carbon Steel: Coat carbon steel operating at a service temperature of between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

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.

3.2 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, soften, or otherwise attack insulation or jacket in either wet or dry state.

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. 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.

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.
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 2 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 more than 25 percent of its nominal thickness.

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.

3.3 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

3.4 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.

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 fittings made from same material and density as that of adjacent pipe insulation. Each piece shall be 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 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 shall conform 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.

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed 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 mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as that of straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as that of straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.

3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.6 INSTALLATION OF FIELD-APPLIED JACKETS

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

3.7 FINISHES

A. Insulation with Glass-Cloth: Paint jacket with paint system identified in Section 230553 - Identification for HVAC Piping and Equipment.

3.8 FIELD QUALITY CONTROL

A. Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. All insulation applications will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.9 PIPING INSULATION SCHEDULE, GENERAL

A. Insulation conductivity and thickness per pipe size shall 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.

3.10 INDOOR PIPING INSULATION SCHEDULE

A. Heating-Hot-Water Supply and Return, 200 Deg F (93 Deg C) and Below: Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.

3.11 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. Piping, Exposed:

1. Glass cloth matching existing.

SECTION 230900 - BUILDING MANAGEMENT SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Building Management System (BMS), utilizing direct digital controls.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Products Supplied but Not Installed Under This Section:
   1. Control valves.
   2. Flow switches.
   3. Wells, sockets and other inline hardware for water sensors (temperature, pressure, flow).
   4. Automatic control dampers, where not supplied with equipment.
   5. Airflow measuring stations.
   6. Terminal unit controllers and actuators, when installed by terminal unit manufacturer.
   7. Variable frequency drives. (This does not include VFDs integral to machinery such as chillers or boilers).

B. Products Installed but Not Supplied Under This Section:
   1. None.

C. Products Not Furnished or Installed but Integrated with the Work of This Section:
   1. Smoke detectors (through alarm relay contacts).

D. Work Required Under Other Divisions Related to This Section:
   1. Power wiring to line side of motor starters, disconnects or variable frequency drives.
   2. Provision and wiring of smoke detectors and other devices relating to fire alarm system.
   3. Campus LAN (Ethernet) connection adjacent to JACE network management controller.

1.3 SYSTEM DESCRIPTION

A. Scope: Furnish all labor, materials and equipment necessary for a complete and operating Building Management System (BMS), utilizing Direct Digital Controls as shown on the drawings and as described herein. Drawings are diagrammatic only. All controllers furnished in this section must communicate on a peer-to-peer bus over a LonTalk, BACnet, or IP Based open protocol bus. All controllers on the LonTalk bus must be LonMark certified.
   1. The intent of this specification is to provide a system that is consistent with BMS systems throughout the owner's facilities running the Niagara 4 Framework.
   2. System architecture must fully support a multi-vendor environment and be able to integrate third party systems via existing vendor protocols including, as a minimum, LonTalk, BACnet and MODBUS.
   3. System architecture must provide secure Web access using any of the current versions of Microsoft Internet Explorer, Mozilla Firefox, or Google Chrome browsers from any computer on the owner's LAN.
   4. All control devices, including configurable and fully programmable controllers, furnished with this Section must be programmable directly from the Niagara 4 Workbench embedded toolset upon completion of this project. The use of configurable or programmable controllers that require additional software tools must not be acceptable.
   5. Any control vendor that must provide additional BMS server software must be unacceptable. Only systems that utilize the Niagara 4 Framework must satisfy the

requirements of this section.

6. The BMS server must host all graphic files for the control system. All graphics and navigation schemes for this project must match those that are on the existing campus NiagaraAX or Niagara 4 Framework server.
7. A new laptop computer including engineering/programming software to modify Operating System Server BMS programs and graphics must be included. An IPAD may be requested for monitoring of building operations and graphic access and will be job specific per a request by UNCW if required (Owner's discrepancy)
8. Owner must receive all Administrator level login and passwords for engineering toolset at first training session. The Owner must have full licensing and full access rights for all network management, operating system server, engineering and programming software required for the ongoing maintenance and operation of the BMS. UNCW will be responsible for setting up desired user accounts with necessary access limits per each
9. user's requirements and allowances.
10. OPEN NIC STATEMENTS - All Niagara 4 software licenses must have the following NiCS: "accept.station.in=*"; "accept.station.out=*"and "accept.wb.in=*"and "accept.wb.out=*". All open NIC statements must follow Niagara Open NIC specifications.
11. All JACE hardware licenses and certificates must be stored on local MicroSD memory card employing encrypted "safe boot" technology.
12. All JACE's provided as part of this project must be the appropriate JACE-8000 model licensed with all necessary drivers.
13. Approved Manufacturers: Honeywell, TAC I/A Series, Distech, Trane.
14. Approved Installation Contractors: Engineered Control Solutions, Schneider Electric CMS Controls

1.4 SPECIFICATION NOMENCLATURE

A. Acronyms used in this specification are as follows:

1. Actuator: Control device that opens or closes valve or damper in response to control signal.
2. AI: Analog Input.
3. AO: Analog Output.
4. Analog: Continuously variable state over stated range of values.
5. BMS: Building Management System.
6. DDC: Direct Digital Control.
7. Discrete: Binary or digital state.
8. DI: Discrete Input.
9. DO: Discrete Output.
10. FC: Fail Closed position of control device or actuator. Device moves to closed position on loss of control signal or energy source.
11. FO: Fail open (position of control device or actuator). Device moves to open position on loss of control signal or energy source.
12. GUI: Graphical User Interface.
13. HVAC: Heating, Ventilating and Air Conditioning.
14. IDC: Interoperable Digital Controller.
15. ILC: Interoperable Lon Controller.
16. LAN: Local Area Network.
17. Modulating: Movement of a control device through an entire range of values, proportional to an infinitely variable input value.
18. Motorized: Control device with actuator.
19. NAC: Network Area Controller.

20. NC: Normally closed position of switch after control signal is removed or normally closed position of manually operated valves or dampers.
21. NO: Normally open position of switch after control signal is removed; or the open position of a controlled valve or damper after the control signal is removed; or the usual position of a manually operated valve.
22. OSS: Operating System Server, host for system graphics, alarms, trends, etc.
23. Operator: Same as actuator.
24. PC: Personal Computer.
25. Peer-to-Peer: Mode of communication between controllers in which each device connected to network has equal status and each shares its database values with all other devices connected to network.
26. P: Proportional control; control mode with continuous linear relationship between observed input signal and final controlled output element.
27. PI: Proportional-Integral control, control mode with continuous proportional output plus additional change in output based on both amount and duration of change in controller variable (reset control).
28. PICS: BACnet Product Interoperability Compliance Statement.
29. PID: Proportional-Integral-Derivative control, control mode with continuous correction of final controller output element versus input signal based on proportional error, its time history (reset) and rate at which it's changing (derivative).
30. Point: Analog or discrete instrument with addressable database value.
31. WAN: Wide Area Network.

1.5 SUBMITTALS

A. Submit under provisions of Section 01 30 00.

B. 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 methods.

C. Submit documentation of contractor qualifications, including those indicated in "Quality Assurance" if requested by the A-E.

D. Electronic copies of shop drawings of the entire control system must be submitted and must consist of a complete list of equipment and materials, including manufacturers' catalog data sheets and installation instructions. Submit in printed electronic format. Samples of written Controller Checkout Sheets and Performance Verification Procedures for applications similar in scope must be included for approval.

E. Shop drawings must also contain complete wiring and schematic diagrams, sequences of operation, control system bus layout and any other details required to demonstrate that the system has been coordinated and will properly function as a system. Terminal identification for all control wiring must be shown on the shop drawings.

F. Upon completion of the work, provide three (3) complete sets of ' as-built' drawings and other project-specific documentation in 3-ring hard-backed binders and one electronic copy.

G. Any deviations from these specifications or the work indicated on the drawings must be clearly identified in the Submittals.

H. All control panels associated with a field device such as air handlers and water systems must

have a laminated page copy of the writing schematic and detail attached to the control cabinet.

I. A software copy of the controls as-built must be supplied and downloaded to the local system network controller (SNC) in 2 different formats. One PDF format and another in the format (Visio) used to produce and engineer the original document as to allow UNCW to modify the as-builts in future changes, construction, and modifications to the controls system.

1.6 QUALITY ASSURANCE

A. The Control System Contractor must have a full service DDC office within 50 miles of the job site. This office must be staffed with applications engineers, software engineers and field technicians. The Control System Contractor must be staffed with a minimum of ten (10) Niagara 4 certified software engineers and/or technicians. The Control System Contractor must maintain parts inventory and must have all testing and diagnostic equipment necessary to support this work, as well as staff trained in the use of this equipment.

B. Single Source Responsibility of Supplier: The Control System Contractor must be responsible for the complete installation and proper operation of the control system. The Control System Contractor must exclusively be in the regular and customary business of design, installation and service of computerized building management systems similar in size and complexity to the system specified. The Control System Contractor must be the manufacturer of the primary DDC system components or must have been the authorized representative for the primary DDC components manufacturer for at least 10 years. All control panels must be assembled by the Control System Contractor in a UL-Certified 508A panel shop. Control panels must be assembled such that all necessary I/O points are pre-wired to terminal blocks. Wire ducts must be installed within the panel as needed to accommodate field wiring.

C. Equipment and Materials: Equipment and materials must be cataloged products of manufacturers regularly engaged in the production and installation of HVAC control systems. Products must be manufacturer's latest standard design and have been tested and proven in actual use.

1.7 SOFTWARE OWNERSHIP

A. The Owner must have full ownership and full access rights for all network management, operating system server, engineering and programming software required for the ongoing maintenance and operation of the BMS.

1.8 DELIVERY, STORAGE AND HANDLING

A. Maintain integrity of shipping cartons for each piece of equipment and control device through shipping, storage and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

1.9 JOB CONDITIONS

A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to ensure that the Work will be carried out in an orderly fashion. It must be this Contractor's responsibility to check the Contract Documents for possible conflicts between his Work and that of other crafts in equipment location, pipe, duct and conduit runs, electrical outlets and fixtures, air diffusers and structural and architectural features.

1.10 SEQUENCING

A. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

PART 2 - PRODUCTS

2.1 GENERAL

A. The Building Management System (BMS) must be comprised of a network of interoperable, stand-alone digital controllers, a network area controller, graphics and programming and other control devices for a complete system as specified herein.

B. The installed system must provide secure strong password access to all features, functions and data contained in the overall BMS.

2.2 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURE

A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system utilizing the LonWorks technology communication protocol in one open, interoperable system.

B. The supplied computer software must employ object-oriented technology (OOT) for representation of all data and control devices within the system. Physical connection of any BACnet control equipment, such as chillers, must be via Ethernet or IP.

C. All components and controllers supplied under this contract must be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data must not be acceptable.

D. The supplied system must incorporate the ability to access all data using HTML5 enabled browsers without requiring proprietary operator interface and configuration programs or browser plug-ins. An Open Database Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data must reside on the Operating System Server located in the Facilities Office on the LAN. Systems requiring proprietary database and user interface programs must not be acceptable.

E. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a "flat" single tiered architecture must not be acceptable.
   1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation must not exceed 5 seconds for network connected user interfaces.
   2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation must not exceed 60 seconds for remote or dial-up connected user interfaces.

2.3 BAS SERVER HARDWARE (Provided by Owner)

A. Minimum Computer Configuration (Hardware Independent).
   1. Central Server. Owner must provide a dedicated BAS server with configuration that includes the following components as a minimum:
   2. Processor: Intel Xeon CPU E5-2640 x64 (or better), compatible with dual- and quad-core processors.
   3. Memory: 8 GB or more.
   4. Hard Drive: 80 GB minimum, more recommended depending on archiving requirements.

5. Display: Video card and monitor capable of displaying 1024 x 768 pixel resolution or greater.
6. Network Support: Ethernet adapter (10/100 Mb with RJ-45 connector).
7. Connectivity: Full-time high-speed ISP connection recommended for remote site access (i.e. T1, ADSL, cable modem).

B. Standard Client: The thin-client Web Browser BAS GUI must be Microsoft Internet Explorer (10.0 or later) running on Microsoft 7+. No special software must be required to be installed on the PCs used to access the BAS via a web browser.

2.4 SYSTEM NETWORK CONTROLLER (SNC)

A. These controllers are designed to manage communications between the programmable equipment controllers (PEC), application specific controllers (ASC) and advanced unitary controllers (AUC) which are connected to its communications trunks, manage communications between itself and other system network controllers (SNC) and with any operator workstations (OWS) that are part of the BAS, and perform control and operating strategies for the system based on information from any controller connected to the BAS.

B. The controllers must be fully programmable to meet the unique requirements of the facility it must control.

C. The controllers must be capable of peer-to-peer communications with other SNC's and with any OWS connected to the BAS, whether the OWS is directly connected, connected via cellular modem or connected via the Internet.

D. The communication protocols utilized for peer-to-peer communications between SNC's will be Niagara 4 Fox, BACnet TCP/IP and SNMP. Use of a proprietary communication protocol for peer-to-peer communications between SNC's is not allowed.

E. The SNC must employ a device count capacity license model that supports expansion capabilities.

F. The SNC must be enabled to support and must be licensed with the following Open protocol drivers (client and server) by default:
1. BACnet
2. Lon
3. MODBUS
4. SNMP
5. KNX

G. The SNC must be capable of executing application control programs to provide:
1. Calendar functions.
2. Scheduling.
3. Trending.
4. Alarm monitoring and routing.
5. Time synchronization.
6. Integration of LonWorks, BACnet, and MODBUS controller data.
7. Network management functions for all SNC, PEC and ASC based devices.

H. The SNC must provide the following hardware features as a minimum:
1. Two 10/100 Mbps Ethernet ports.
2. Two Isolated RS-485 ports with biasing switches.
3. 1 GB RAM

4. 4 GB Flash Total Storage / 2 GB User Storage
5. Wi-Fi (Client or WAP)
6. USB Flash Drive
7. High Speed Field Bus Expansion
8. -20-60°C Ambient Operating Temperature
9. Integrated 24 VAC/DC Global Power Supply
10. MicroSD Memory Card Employing Encrypted Safe Boot Technology

I. The SNC must support standard Web browser access via the Intranet/Internet. It must support a minimum of 16 simultaneous users.

J. The SNC must provide alarm recognition, storage, routing, management and analysis to supplement distributed capabilities of equipment or application specific controllers.

K. The SNC must be able to route any alarm condition to any defined user location whether connected to a local network or remote via cellular modem, or wide-area network.
   1. Alarm generation must be selectable for annunciation type and acknowledgement requirements including but not limited to:
      a. Alarm.
      b. Return to normal.
      c. To default.
   2. Alarms must be annunciated in any of the following manners as defined by the user:
      a. Screen message text.
      b. Email of complete alarm message to multiple recipients.
      c. Pagers via paging services that initiate a page on receipt of email message.
      d. Graphics with flashing alarm object(s).
   3. The following must be recorded by the SNC for each alarm (at a minimum):
      a. Time and date.
      b. Equipment (air handler #, access way, etc.).
      c. Acknowledge time, date, and user who issued acknowledgement.
   4. Alarms classes must be created in the local station to match N4 Supervisor class naming in the following manner with same naming for priority routing and annunciation. (listed in order of priority from highest to lowest)
      a. Critical Alarms (Priority 1)
      b. High Priority (Priority 2)
      c. Space Temp Alarms (Priority 3)
      d. Generator Alarms (Priority 3) (if required)
      e. Plumbers Alarms (Priority 3) (if required)
      f. Mid Priority (Priority 4)
      g. Low Priority (Priority 5)
      h. Ping Alarms (Priority 6)
      i. *Back to normal state (Priority 7)*
   5. All alarm classes in the local station must be directed to the N4 station recipient for routing. The Supervisors “Supervisor Console” should be added to a Px view accessible via a hyperlink with a filter applied to show only the selected buildings alarms on the appropriate buildings’ graphics alarm page.
      a. Time Stamp
      b. Source
      c. Source State
      d. Alarm State
      e. Priority

f. Alarm Class
g. Ack or Clear Action link

L. Programming software and all controller "Setup Wizards" must be embedded into the SNC.

M. The SNC must support the following security functions.
1. Module code signing to verify the author of programming tool and confirm that the code has not been altered or corrupted.
2. Role-Based Access Control (RBAC) for managing user roles and permissions.
3. Require users to use strong credentials.
4. Data in Motion and Sensitive Data at Rest be encrypted.
5. LDAP and Kerberos integration of access management.

N. The SNC must support the following data modeling structures to utilize Search; Hierarchy; Template; and Permission functionality:
1. Metadata: Descriptive tags to define the structure of properties.
2. Tagging: Process to apply metadata to components
3. Tag Dictionary

O. The SNC must employ template functionality. Templates are a containerized set of configured data tags, graphics, histories, alarms... that are set to be deployed as a unit based upon manufacturer's controller and relationships. All lower level communicating controllers (PEC, AVAV, CVAV, VFD) must have an associated template file for reuse on future project additions.

P. The SNC point naming must follow a standard as set for a standardized naming convention. This naming standard must be applied to the SNC as well as the BAS Server Supervisor for all points related to setpoints, monitoring points, trending, alarming, and graphics

Q. The SNC must be provided with a 1 Year Software Maintenance license. Labor to implement not included.

2.5 BUILDING AUTOMATION SYSTEM CONTROLLERS

A. HVAC control must be accomplished using LonMark based devices. The controller platform must provide options and advanced system functions, programmable and configurable using Niagara 4 Framework, that allow standard and customizable control solutions required in executing the "Sequence of Operation".
1. Programmable Equipment Controllers - a controller designed for more complex sequences of operations such as built up AHU's, central plant operations, electrical monitoring, and control and management for chillers, boilers and generators. The PECs are to allow for the flexibility of custom control programming to meet the needed sequences of operation. PEC's must be selected based upon I/O requirements. Additional I/O may be added via expansion modules.
a. All PECs must be application programmable and must at all times maintain their certification. All control sequences within or programmed into the PEC must be stored in non-volatile memory, which is not dependent upon the presence of a battery to be retained.
b. The PEC must provide LED indication of communication and controller performance to the technician, without cover removal.
c. PEC's must have mixture of I/O including dry contact digital inputs, universal inputs (configurable as 0-10V, 0-10,000 ohm or, 20K NTC), analog outputs (4-20mA), and digital outputs (24 VAC TRIAC or relay).

2. Advanced Variable Air Volume Controller (AVAV) - a controller designed specifically for room-level VAV control - pressure-independent air flow control, pressure dependent damper control, supply and exhaust pressurization/de-pressurization control; temperature, humidity, complex CO2, occupancy, and emergency control. Equipment includes: VAV terminal unit, VAV terminal unit with reheat, series fan powered terminal unit, parallel fan powered terminal unit, supply and exhaust air volume terminals and constant volume dual-duct terminal unit.
    a. The AVAV must be application programmable and must at all times maintain their certification. All control sequences within or programmed into the PEC must be stored in non-volatile memory, which is not dependent upon the presence of a battery to be retained.
    b. The controller must have an internal velocity pressure sensor.
    c. The AVAV must provide LED indication of communication and controller performance to the technician, without cover removal.
    d. AVAV's must have mixture of I/O including dry contact digital inputs, universal inputs (configurable as 0-10V, 0-10,000 ohm or, 20K NTC), analog outputs (4-20mA), and digital outputs (24 VAC TRIAC).
    e. The controller must provide an integrated actuator option.
3. Configurable VAV Controller (CVAV) - the configurable VAV controller platform must be designed specifically for room-level VAV control – pressure-independent air flow control, pressure dependent damper control, supply and exhaust pressurization/de-pressurization control; temperature, humidity, complex CO2, occupancy, and emergency control. Equipment includes: VAV terminal unit, VAV terminal unit with reheat, series fan powered terminal unit, parallel fan powered terminal unit, supply and exhaust air volume terminals, and constant volume dual-duct terminal unit.
    a. The CVAV must be application specific configuration and must at all times maintain their certification. All control sequences within or programmed into the CVAV must be stored in non-volatile memory, which is not dependent upon the presence of a battery to be retained.
    b. The controller must have an internal velocity pressure sensor.
    c. The CVAV must provide LED indication of communication and controller performance to the technician, without cover removal.
    d. CVAV's must have mixture of I/O including dry contact digital inputs, universal inputs (configurable as 0-10V, 0-10,000 ohm or, 20K NTC), analog outputs (4-20mA), and digital outputs (24 VAC TRIAC).
    e. The controller must provide an integrated actuator option.
4. Configurable Constant Volume AHU Controller (CVAHU) - the configurable constant volume AHU controller must be designed specifically for single zone unitary AHU control –temperature, humidity, complex CO2, occupancy, and emergency control. Equipment includes: unitary air handling units, fan coil units, blower coil units, unit ventilators, and heat pumps.
    a. The CVAHU controller must be application specific configuration and must at all times maintain their certification. All control sequences within or programmed into the CVAHU controller must be stored in non-volatile memory, which is not dependent upon the presence of a battery to be retained.
    b. The CVAHU controller must provide LED indication of communication and controller performance to the technician, without cover removal.
    c. CVAHU controllers must have mixture of I/O including dry contact digital inputs, universal inputs (configurable as 0-10V, 0-10,000 ohm or, 20K NTC), analog outputs (4-20mA), and digital outputs (24 VAC TRIAC).

2.6 OTHER CONTROL SYSTEM HARDWARE

A. Utility metering devices, (water, electric, and gas) must be non-pulse devices with non-volatile memory communicated directly to a gateway such as SCADA metrics Ethermeter, Onicon D-100, or kW switchgear meters which will be communicated to the building and supervisor Niagara system.

B. HVAC local non-programmable and non-configurable integration devices, (boilers, VFD's, and utility meters) must use LonMark, BACnet, Modbus, or IP based devices to communicate.

C. Motorized control dampers that will not be integral to the equipment must be furnished by the Control System Contractor. Control damper frames must be constructed of galvanized steel, formed into changes and welded or riveted. Dampers must be galvanized, with nylon bearings. Blade edge seals must be vinyl. Blade edge and tip seals must be included for all dampers. Blades must be 16-gauge minimum and 6 inches wide maximum and frame must be of welded channel iron. Damper leakage must not exceed 10 CFM per square foot, at 1.5 inches water gauge static pressure.

D. Control damper actuators must be furnished by the Control System Contractor. Two-position or proportional electric actuators must be direct-mount type sized to provide a minimum of 5 in-lb torque per square foot of damper area. Damper actuators must be spring return type. Operators must be heavy-duty electronic type for positioning automatic dampers in response to a control signal. Motor must be of sufficient size to operate damper positively and smoothly to obtain correct sequence as indicated. All applications requiring proportional operation must utilize truly proportional electric actuators.

E. Control Valves: Control valves must be 2-way or 3-way pattern as shown and constructed for tight shutoff at the pump shut-off head or steam relief valve pressure. Control valves must operate satisfactorily against system pressures and differentials. Two-position valves must be ' line' size. Proportional control valves must be sized for a maximum pressure drop of 5.0 psi at rated flow (unless otherwise noted or scheduled on the drawings). Valves with sizes up to and including 2 inches (51 mm) must be "screwed" configuration and 2-1/2 inches (63.5 mm) and larger valves must be "flanged" configuration. All control valves, including terminal unit valves, less than 2 inches (51 mm) must be globe valves. Electrically-actuated control valves must include spring return type actuators sized for tight shut-off against system pressures (as specified above) and, when specified, must be furnished with integral switches for indication of valve position (open-closed). Pneumatic actuators for valves, when utilized, must be sized for tight shut-off against system pressures (as specified above).

F. Control Valve Actuators: Actuators for VAV terminal unit heating coils must be "drive-open; drive-closed" type. All actuators must have inherent current limiting motor protection. Valve actuators must be 24-volt, electronic type, modulating or two-position as required for the correct operating sequence. Actuators on valves needing ' fail-safe' operation must have spring return to Normal position. Modulating valves must be positive positioning in response to the signal. All valve actuators must be UL listed. Honeywell is basis of design.

G. All control valves 2-1/2 inches (63.5 mm) or larger must have position indication. All hot water control valves must be Normally-Open arrangement; all chilled water control valves must be Normally-Closed arrangement.

H. Wall Mount Room Temperature sensors: Each room temperature sensor must provide temperature indication to the digital controller, provide the capability for a software-limited

occupant set point adjustment (warmer-cooler slider bar or switch) and limited operation override capability. Room Temperature Sensors must be 20,000-ohm thermistor type with a temperature range of -40 to 140 degrees F (-38 to 60 degrees C). The sensor must be complete with a decorative cover and suitable for mounting over a standard electrical utility box. These devices must have an accuracy of 0.5 degrees F (.024 degrees C) over the entire range.

I. Duct-mounted and Outside Air Temperature Sensors: 20,000-ohm thermistor temperature sensors with an accuracy of ±; 0.2 degrees C. Outside air sensors must include an integral sun shield. Duct-mounted sensors must have an insertion measuring probe of a length appropriate for the duct size, with a temperature range of -40 to 160 degrees F(-38 to 71 degrees C) The sensor must include a utility box and a gasket to prevent air leakage and vibration noise. For all mixed air and preheat air applications, install bendable averaging duct sensors with a minimum 8 feet (2438 mm) long sensor element. These devices must have accuracy of 0.5 degrees F (.024 degrees C) over the entire range.

J. Humidity sensors must be thin-film capacitive type sensor with on-board nonvolatile memory, accuracy to plus or minus two percent (2%) at 0 to 90% RH, 12 - 30 VDC input voltage, analog output (0 - 10 VDC or 4 - 20mA output). Operating range must be 0 to 100% RH and 32 to 140 degrees F (0 to 60 degrees C). Sensors must be selected for wall, duct or outdoor type installation as appropriate. Honeywell is basis of design.

K. Carbon Dioxide Sensors (CO2): Sensors must utilize Non-dispersive infrared technology (N.D.I.R.), repeatable to plus or minus 20 PPM. Sensor range must be 0 - 2000 PPM. Accuracy must be plus or minus five percent (5%) or 75 PPM, whichever is greater. Response must be less than one minute. Input voltage must be 20 to 30 VAC or DC. Output must be 0 - 10 VDC. Sensor must be wall or duct mounted type, as appropriate for the application, housed in a high impact plastic enclosure.

L. Current Sensitive Switches: Solid state, split core current switch that operates when the current level (sensed by the internal current transformer) exceeds the adjustable trip point. Current switch to include an integral LED for indication of trip condition and a current level below trip set point.

M. Differential Analog (duct) Static Pressure Transmitters Provide a pressure transmitter with integral capacitance type sensing and solid-state circuitry. Accuracy must be plus or minus 1% of full range; range must be selected for the specific application. Provide zero and span adjustment capability. Device must have integral static pickup tube.

N. Differential Air Pressure Switches: Provide SPDT type, UL-approved, and selected for the appropriate operating range where applied. Switches must have adjustable set points and barbed pressure tips.

O. Water Flow Switches: Provide a SPST type contact switch with bronze paddle blade, sized for the actual pipe size at the location. If installed outdoors, provide a NEMA-4 enclosure. Flow switch must be UL listed.

P. Temperature Control Panels: Furnish temperature control panels of code gauge steel with locking doors for mounting all devices as shown. All electrical devices within a control panel must be factory wired. Control panel must be assembled by the BMS in a UL-Certified 508A panel shop. A complete set of ' as-built' control drawings (relating to the controls within that panel) must be furnished within each control panel.

Q. Pipe and Duct Temperature sensing elements: 20,000-ohm thermistor temperature sensors with and accuracy of ±1% accuracy. Their range must be -5 to 250 degrees F (-20 to 121 degrees C).

Limited range sensors must be acceptable provided they are capable of sensing the range expected for the point at the specified accuracy. Thermal wells with heat conductive gel must be included.

R. Low Air Temperature Sensors: Provide SPST type switch, with 15 to 55 degrees F (-9 to 13 degrees C), range, vapor-charged temperature sensor. Honeywell model L482A, or approved equivalent.

S. Variable Frequency Drives: The variable frequency drive (VFD) must be designed specifically for use in Heating, Ventilation, and Air Conditioning (HVAC) applications in which speed control of the motor can be applied. The VFD, including all factory installed options, must have UL & CSA approval. VFD's must include communications capability with DDC BMS via built-in interface card (MODBUS or BACnet). Honeywell SmartVFD is basis of design.

T. Relays: Start/stop relay model must provide either momentary or maintained switching action as appropriate for the motor being started. All relays must be plugged in, interchangeable, mounted on a sub base and wired to numbered terminals strips. Relays installed in panels must all be DPDT with indicating lamp. Relays installed outside of controlled devices must be enclosed in a NEMA enclosure suitable for the location. Relays must be labeled with UR symbol. RIB-style relays are acceptable for remote enable/disable.

U. Emergency Stop Switches: Provide toggle-type switch with normally-closed contact. Switch must be labeled "AIR HANDLER EMERGENCY SHUTOFF, NORMAL - OFF.".

V. Transducers: Differential pressure transducers must be electronic with a 4-20 mA output signal compatible to the Direct Digital Controller. Wetted parts must be stainless steel. Unit must be designed to operate in the pressure ranges involved.

W. Control Power Transformers: Provide step-down transformers for all DDC controllers and devices as required. Transformers must be sized for the load, but must be sized for 50 watts, minimum. Transformers must be UL listed Class 2 type, for 120 VAC/24 VAC operation.

X. Line voltage protection: All DDC system control panels that are powered by 120 VAC circuits must be provided with surge protection. This protection is in addition to any internal protection provided by the manufacturer. The protection must meet UL, ULC 1449, IEEE C62.41B. A grounding conductor, (minimum 12 AWG), must be brought to each control panel.

Y. Lon Bus Surge Protectors: A Lon Bus Surge Protector, DITEK model # DTK-2MHLP24BWB or equivalent must be installed on the lon bus when it leaves and enters a building.

Z. Ethernet Port Surge Protector: An Ethernet Surge protector must be installed similar to the Honeywell 14507678-004 or comparable.

AA. Airflow Monitoring Stations: Ebtron Brand airflow monitoring stations must be Lon. Controls Contractor must verify installed duct sizes and airflows before ordering.

BB. Gas Meters: Onicon brand F-5400 Series Thermal Mass Flow Meter, D-100 display with LonWorks TP/FT-10F Output. Controls Contractor must verify installed pipe size, meter placement sizes and flows before ordering.

CC. Domestic Water Meters:
1. Building meters: Neptune with Neptune E-Coder register w/ the potted cable.
    a. 1.5 inches and below must be positive displacement type with matching strainer.
    b. 2 inches and above must be compound type meter with matching strainer.

2. Irrigation meters: Neptune
   a. Minimum 2" turbine meter with matching strainer
3. Meter Register: Neptune E-Coder register w/ the potted cable. (The R900i register is NOT compatible, since it does not feature a connection wire.)
4. Meter Gateway: Scadametrics Ethermeter http://www.scadametrics.com/ The gateway device must directly interrogate the meter register and must calculate and relay the following parameters to the BMS: Totalized Volume, Instantaneous Flowrate

DD. BTU Meters: Onicon System-10 BTU meter, LonWorks communication, F-3500 Electromagnetic Flow Meter.

EE. Electric Meter: Digital Electric Meter with Modbus communication (Honeywell / E-Mon Class 3200 Smart Meter With MODBUS RTU communication, basis of design). Unit must display and communicate totalized kWH, voltage, amps, kW.

FF. Liquid Flow Meters: Onicon F-3500 Electromagnetic Flow Meter, D-100 Display with LonWorks Communication (other Onicon displays allowed with designer approval).

2.7 BAS SERVER & WEB BROWSER GUI - SYSTEM OVERVIEW

A. The BAS Contractor must provide system software based on server/thin-client architecture, designed around the open standards of web technology. The BAS server must communicate using Ethernet and TCP. Server must be accessed using a web browser over Owner intranet and remotely over the Internet.

B. The intent of the thin-client architecture is to provide the operator(s) complete access to the BAS system via a web browser. The thin-client web browser Graphical User Interface (GUI) must be browser and operating system agnostic, meaning it will support HTML5 enabled browsers without requiring proprietary operator interface and configuration programs or browser plug-ins. Microsoft, Firefox, and Chrome browsers (current released versions), and Windows as well as non-Window operating systems.

C. The BAS server software must support at least the following server platforms (Windows 7, 8.1, Server 12). The BAS server software must be developed and tested by the manufacturer of the system stand-alone controllers and network controllers/routers.

D. The web browser GUI must provide a completely interactive user interface and must provide a HTML5 experience that supports the following features as a minimum:
1. Trending.
2. Scheduling.
3. Electrical demand limiting.
4. Duty Cycling.
5. Downloading Memory to field devices.
6. Real time 'live' Graphic Programs.
7. Tree Navigation.
8. Parameter change of properties.
9. Set point adjustments.
10. Alarm / event information.
11. Configuration of operators.
12. Execution of global commands.
13. Add, delete, and modify graphics and displayed data.

E. Software Components: All software must be the most current version. All software components

of the BAS system software must be provided and installed as part of this project. BAS software components must include:

1. Server Software, Database and Web Browser Graphical User Interface.
2. 5 Year Software Maintenance license. Labor to implement not included.
3. Embedded System Configuration Utilities for future modifications to the system and controllers.
4. Embedded Graphical Programming Tools.
5. Embedded Direct Digital Control software.
6. Embedded Application Software.

F. BAS Server Database: The BAS server software must utilize a Java Database Connectivity (JDBC) compatible database such as: MS SQL 8.0, Oracle 8i or IBM DB2. BAS systems written to Non -Standard and/or Proprietary databases are NOT acceptable.

G. Thin Client - Web Browser Based: The GUI must be thin client or browser based and must meet the following criteria:

1. Web Browser's for PC's: Only the current released browser (Explorer/Firefox/Chrome) will be required as the GUI and a valid connection to the server network. No installation of any custom software must be required on the operator's GUI workstation/client. Connection must be over an intranet or the Internet.
2. Secure Socket Layers: Communication between the Web Browser GUI and BAS server must offer encryption using 128-bit encryption technology within Secure Socket Layers (SSL). Communication protocol must be Hyper-Text Transfer Protocol (HTTP).

2.8 WEB BROWSER GRAPHICAL USER INTERFACE

A. Web Browser Navigation: The Thin Client web browser GUI must provide a comprehensive user interface. Using a collection of web pages, it must be constructed to "feel" like a single application, and provide a complete and intuitive mouse/menu driven operator interface. It must be possible to navigate through the system using a web browser to accomplish requirements of this specification. The Web Browser GUI must (as a minimum) provide for navigation, and for display of animated graphics, schedules, alarms/events, live graphic programs, active graphic set point controls, configuration menus for operator access, reports and reporting actions for events.

B. Login: On launching the web browser and selecting the appropriate domain name or IP address, the operator must be presented with a login page that will require a login name and strong password. Navigation in the system must be dependent on the operator's role-based application control privileges.

C. Navigation: Navigation through the GUI must be accomplished by clicking on the appropriate level of a navigation tree (consisting of an expandable and collapsible tree control like Microsoft's Explorer program) and/or by selecting dynamic links to other system graphics. Both the navigation tree and action pane must be displayed simultaneously, enabling the operator to select a specific system or equipment and view the corresponding graphic. The navigation tree must as a minimum provide the following views: Geographic, Network, Groups and Configuration.

1. Geographic View must display a logical geographic hierarchy of the system including: cities, sites, buildings, building systems, floors, equipment and objects.
2. Groups View must display Scheduled Groups and custom reports.
3. Configuration View must display all the configuration categories (Operators, Schedule, Event, Reporting and Roles).

D. Action Pane: The Action Pane must provide several functional views for each subsystem

specified. A functional view must be accessed by clicking on the corresponding button:

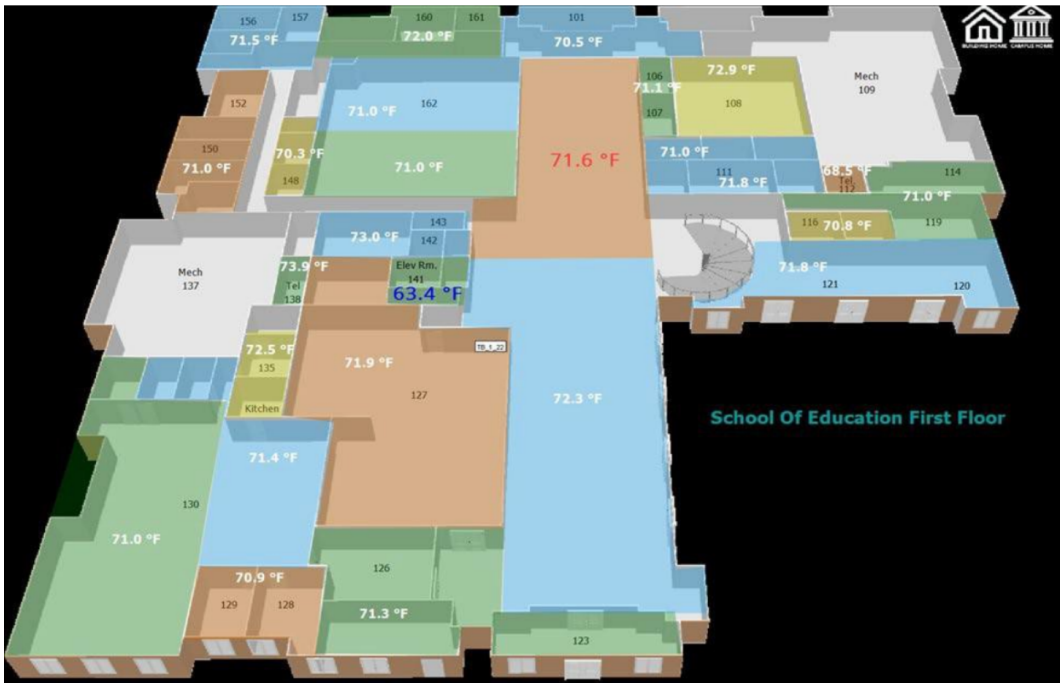
1. Graphics: Using graphical format suitable for display in a web browser, graphics must include aerial building/campus views, color building floor-plans, equipment drawings, active graphic set point controls, web content and other valid HTML elements. The data on each graphic page must automatically refresh.
2. Dashboards: User customizable data using drag and drop HTML5 elements. Must include Web Charts, Gauges, and other custom developed widgets for web browser. User must have ability to save custom dashboards.
3. Search: User must have multiple options for searching data based upon Tags. Associated equipment, real time data, Properties, and Trends must be available in result.
4. Properties: Must include graphic controls and text for the following: Locking or overriding objects, demand strategies, and any other valid data required for setup. Changes made to the properties pages must require the operator to depress an 'accept/cancel' button.
5. Schedules: Must be used to create, modify/edit and view schedules based on the systems hierarchy (using the navigation tree).
6. Alarms: Must be used to view alarm information geographically (using the navigation tree), acknowledge alarms, sort alarms by category, actions and verify reporting actions.
7. Charting: Must be used to display associated trend and historical data, modify colors, date range, axis and scaling. User must have ability to create HTML charts through web browser without utilizing chart builder. User must be able to drag and drop single or multiple data points, including schedules, and apply status colors for analysis.
8. Logic - Live Graphic Programs: Must be used to display' live' graphic programs of the control algorithm, (micro block programming) for the mechanical/electrical system selected in the navigation tree.
9. Other actions such as Print, Help, Command, and Logout must be available via a drop-down window.

E. Color Graphics: The Web Browser GUI must make extensive use of color in the graphic pane to communicate information related to set points and comfort. Animated .gifs or .jpg, vector scalable, active set point graphic controls must be used to enhance usability. Graphics tools used to create Web Browser graphics must be non-proprietary and conform to the following basic criteria:

1. Display Size: The GUI workstation software must graphically display in a minimum of 1024 by 768 pixels 24 bit True Color.
2. General Graphic: General area maps must show locations of controlled buildings in relation to local landmarks.
3. Color Floor Plans: Floor plan graphics must show heating and cooling zones throughout the buildings in a range of colors, as selected by Owner. Provide a visual display of temperature relative to their respective set points. The colors must be updated dynamically as a zone's actual comfort condition changes.
4. Mechanical Components: Mechanical system graphics must show the type of mechanical system components serving any zone through the use of a pictorial representation of components. Selected I/O points being controlled or monitored for each piece of equipment must be displayed with the appropriate engineering units. Animation must be used for rotation or moving mechanical components to enhance usability. .
5. Minimum System Color Graphics: Color graphics must be selected and displayed via a web browser for the following:
    a. Each piece of equipment monitored or controlled including each terminal unit.
    b. Each building.
    c. Each floor and zone controlled.
6. Display Size : The GUI workstation software must graphically display in a minimum of

1024 by 728 pixels 24 bit True Color.

7. General Graphic: General area maps must show locations of controlled buildings in relation to local landmarks.
8. Color Floor Plans: Floor plan graphics must be multi-colored to differentiate between the different zones and areas. Colors selected are based on a neutral palette as to not show a large variance in bright colors but more of a neutral, slightly different tones. Provide a visual display of temperature relative to their respective set points via the use of a color changing font and size that displays the zone temperature. The displayed temperature must change to a red blinking, size 20 font for high space temperature and blue blinking, size 20 font for low space temperature. The colors and font size must be updated as a zone's actual comfort condition changes from a normal range to a high or low out of range measurement.



F. Hierarchical Schedules: Utilizing the Navigation Tree displayed in the web browser GUI, an operator (with proper access credentials) must be able to define a Normal, Holiday or Override schedule for an individual piece of equipment or room, or choose to apply a hierarchical schedule to the entire system, site or floor area. For example, Independence Day ' Holiday' for every level in the system would be created by clicking at the top of the geographic hierarchy defined in the Navigation Tree. No further operator intervention would be required and every control module in the system with would be automatically downloaded with the ' Independence Day' Holiday. All schedules that affect the system/area/equipment highlighted in the Navigation Tree must be shown in a summary schedule table and graph.

1. Schedules: Schedules must comply with the LonWorks and BACnet standards, (Schedule Object, Calendar Object, Weekly Schedule property and Exception Schedule property) and must allow events to be scheduled based on:
   a. Types of schedule must be Normal, Holiday or Override.
   b. A specific date.
   c. A range of dates.
   d. Any combination of Month of Year (1-12, any), Week of Month (1-5, last, any), Day of Week (M-Sun, Any).

e. Wildcard (example, allow combinations like second Tuesday of every month).

2. Schedule Categories: The system must allow operators to define and edit scheduling categories (different types of "things" to be scheduled; for example, lighting, HVAC occupancy, etc.). The categories must include: name, description, icon (to display in the hierarchy tree when icon option is selected) and type of value to be scheduled.
3. Schedule Groups: In addition to hierarchical scheduling, operators must be able to define functional Schedule Groups, comprised of an arbitrary group of areas/rooms/equipment scattered throughout the facility and site. For example, the operator must be able to define an ' individual tenant' group - who may occupy different areas within a building or buildings. Schedules applied to the ' tenant group' must automatically be downloaded to control modules affecting spaces occupied by the ' tenant group'.
4. Intelligent Scheduling: The control system must be intelligent enough to automatically turn on any supporting equipment needed to control the environment in an occupied space. If the operator schedules an individual room in a VAV system for occupancy, for example, the control logic must automatically turn on the VAV air handling unit, chiller, boiler and/or any other equipment required to maintain the specified comfort and environmental conditions within the room.
5. Partial Day Exceptions: Schedule events must be able to accommodate a time range specified by the operator (ex: board meeting from 6 pm to 9 pm overrides Normal schedule for conference room).
6. Schedule Summary Graph: The schedule summary graph must clearly show Normal versus Holiday versus Override Schedules and the net operating schedule that results from all contributing schedules. Note: In case of priority conflict between schedules at the different geographic hierarchy, the schedule for the more detailed geographic level must apply.

G. Alarms: Alarms associated with a specific system, area, or equipment selected in the Navigation Tree, must be displayed in the Action Pane by selecting an ' Alarms' view. Alarms, and reporting actions must have the following capabilities:
1. Alarms View: Each Alarm must display an Alarms Category (using a different icon for each alarm category), date/time of occurrence, current status, alarm report and a bold URL link to the associated graphic for the selected system, area or equipment. The URL link must indicate the system location, address and other pertinent information. An operator must easily be able to sort events, edit event templates and categories, acknowledge or force a return to normal in the Events View as specified in this section.
2. Alarm Categories: The operator must be able to create, edit or delete alarm categories such as HVAC, Maintenance, Fire, or Generator. An icon must be associated with each alarm category, enabling the operator to easily sort through multiple events displayed.
3. Alarm Templates: Alarm template must define different types of alarms and their associated properties. As a minimum, properties must include a reference name, verbose description, severity of alarm, acknowledgement requirements, and high/low limit and out of range information.
4. Alarm Areas: Alarm Areas enable an operator to assign specific Alarm Categories to specific Alarm Reporting Actions. For example, it must be possible for an operator to assign all HVAC Maintenance Alarm on the 1st floor of a building to email the technician responsible for maintenance. The Navigation Tree must be used to setup Alarm Areas in the Graphic Pane.
5. Alarm Time/Date Stamp: All events must be generated at the DDC control module level and comprise the Time/Date Stamp using the standalone control module time and date.
6. Alarm Configuration: Operators must be able to define the type of Alarm generated per object. A ' network' view of the Navigation Tree must expose all objects and their respective Alarm Configuration. Configuration must include assignment of Alarm, type of

Acknowledgement and notification for return to normal or fault status.

7. Alarm Summary Counter: The view of Alarm in the Graphic Pane must provide a numeric counter, indicating how many Alarms are active (in alarm), require acknowledgement and total number of Alarms in the BAS Server database.
8. Alarm Auto-Deletion: Alarms that are acknowledged and closed must be auto-deleted from the database and archived to a text file after an operator defined period.
9. Alarm Reporting Actions: Alarm Reporting Actions specified must be automatically launched (under certain conditions) after an Alarm is received by the BAS server software. Operators must be able to easily define these Reporting Actions using the Navigation Tree and Graphic Pane through the web browser GUI. Reporting Actions must be as follows:
    a. Print: Alarm information must be printed to the BAS server's PC or a networked printer.
    b. Email: Email must be sent via any POP3-compatible e-mail server (most Internet Service Providers use POP3). Email messages may be copied to several email accounts. Note: Email reporting action must also be used to support alphanumeric paging services, where email servers support pagers.
    c. File Write: The ASCII File write reporting action must enable the operator to append operator defined alarm information to any alarm through a text file. The alarm information that is written to the file must be completely definable by the operator. The operator may enter text or attach other data point information (such as AHU discharge temperature and fan condition upon a high room temperature alarm).
    d. Write Property: The write property reporting action updates a property value in a hardware module.
    e. SNMP: The Simple Network Management Protocol (SNMP) reporting action sends an SNMP trap to a network in response to receiving an alarm.
    f. Run External Program: The Run External Program reporting action launches specified program in response to an event.

H. Trends: As system is engineered, all points must be enabled to trend. Trends must both be displayed and user configurable through the Web Browser GUI. Trends must comprise analog, digital or calculated points simultaneously. A trend log's properties must be editable using the Navigation Tree and Graphic Pane.
    1. Viewing Trends: The operator must have the ability to view trends by using the Navigation Tree and selecting a Trends button in the Graphic Pane. The system must allow y- and x-axis maximum ranges to be specified and must be able to simultaneously graphically display multiple trends per graph.
    2. Local Trends: Trend data must be collected locally by Multi-Equipment/Single Equipment general-purpose controllers, and periodically uploaded to the BAS server if historical trending is enabled for the object. Trend data, including run time hours and start time date must be retained in non-volatile module memory. Systems that rely on a gateway/router to run trends are NOT acceptable.
    3. Resolution. Sample intervals must be as small as one second. Each trended point will have the ability to be trended at a different trend interval. When multiple points are selected for displays that have different trend intervals, the system will automatically scale the axis.
    4. Dynamic Update. Trends must be able to dynamically update at operator-defined intervals.
    5. Zoom/Pan. It must be possible to zoom-in on a particular section of a trend for more detailed examination and ' pan through' historical data by simply scrolling the mouse.
    6. Numeric Value Display. It must be possible to pick any sample on a trend and have the numerical value displayed.
    7. Copy/Paste. The operator must have the ability to pan through a historical trend and copy the data viewed to the clipboard using standard keystrokes (i.e. CTRL+C, CTRL+V).

I. Security Access: Systems that Security access from the web browser GUI to BAS server must require a Login Name and Strong Password. Access to different areas of the BAS system must be defined in terms of Role-Based Access Control privileges as specified:
   1. Roles: Roles must reflect the actual roles of different types of operators. Each role must comprise a set of ' easily understood English language' privileges. Roles must be defined in terms of View, Edit and Function Privileges.
      a. View Privileges must comprise: Navigation, Network, and Configuration Trees, Operators, Roles and Privileges, Alarm/Event Template and Reporting Action.
      b. Edit Privileges must comprise: Set point, Tuning and Logic, Manual Override, and Point Assignment Parameters.
      c. Function Privileges must comprise: Alarm/Event Acknowledgement, Control Module Memory Download, Upload, Schedules, Schedule Groups, Manual Commands, Print and Alarm/Event Maintenance.
   2. Geographic Assignment of Roles: Roles must be geographically assigned using a similar expandable/collapsible navigation tree. For example, it must be possible to assign two HVAC Technicians with similar competencies (and the same operator defined HVAC Role) to different areas of the system.

2.9 GRAPHICAL PROGRAMMING

A. The system software must include a Graphic Programming Language (GPL) for all DDC control algorithms resident in all control modules. Any system that does not use a drag and drop method of graphical icon programming must not be accepted. All systems must use a GPL method used to create a sequence of operations by assembling graphic microblocks that represent each of the commands or functions necessary to complete a control sequence. Microblocks represent common logical control devices used in conventional control systems, such as relays, switches, high signal selectors etc., in addition to the more complex DDC and energy management strategies such as PID loops and optimum start. Each microblock must be interactive and contain the programming necessary to execute the function of the device it represents.

B. Graphic programming must be performed while on screen and using a mouse; each microblock must be selected from a microblock library and assembled with other microblocks necessary to complete the specified sequence. Microblocks are then interconnected on screen using graphic "wires," each forming a logical connection. Once assembled, each logical grouping of microblocks and their interconnecting wires then forms a graphic function block which may be used to control any piece of equipment with a similar point configuration and sequence of operation.

C. Graphic Sequence: The clarity of the graphic sequence must be such that the operator has the ability to verify that system programming meets the specifications, without having to learn or interpret a manufacturer's unique programming language. The graphic programming must be self-documenting and provide the operator with an understandable and exact representation of each sequence of operation.

D. GPL Capabilities: The following is a minimum definition of the capabilities of the Graphic Programming software:
   1. Function Block (FB): Must be a collection of points, microblocks and wires which have been connected together for the specific purpose of controlling a piece of HVAC equipment or a single mechanical system.
   2. Logical I/O: Input/Output points must interface with the control modules in order to read various signals and/or values or to transmit signal or values to controlled devices.
   3. Microblocks: Must be software devices that are represented graphically and may be

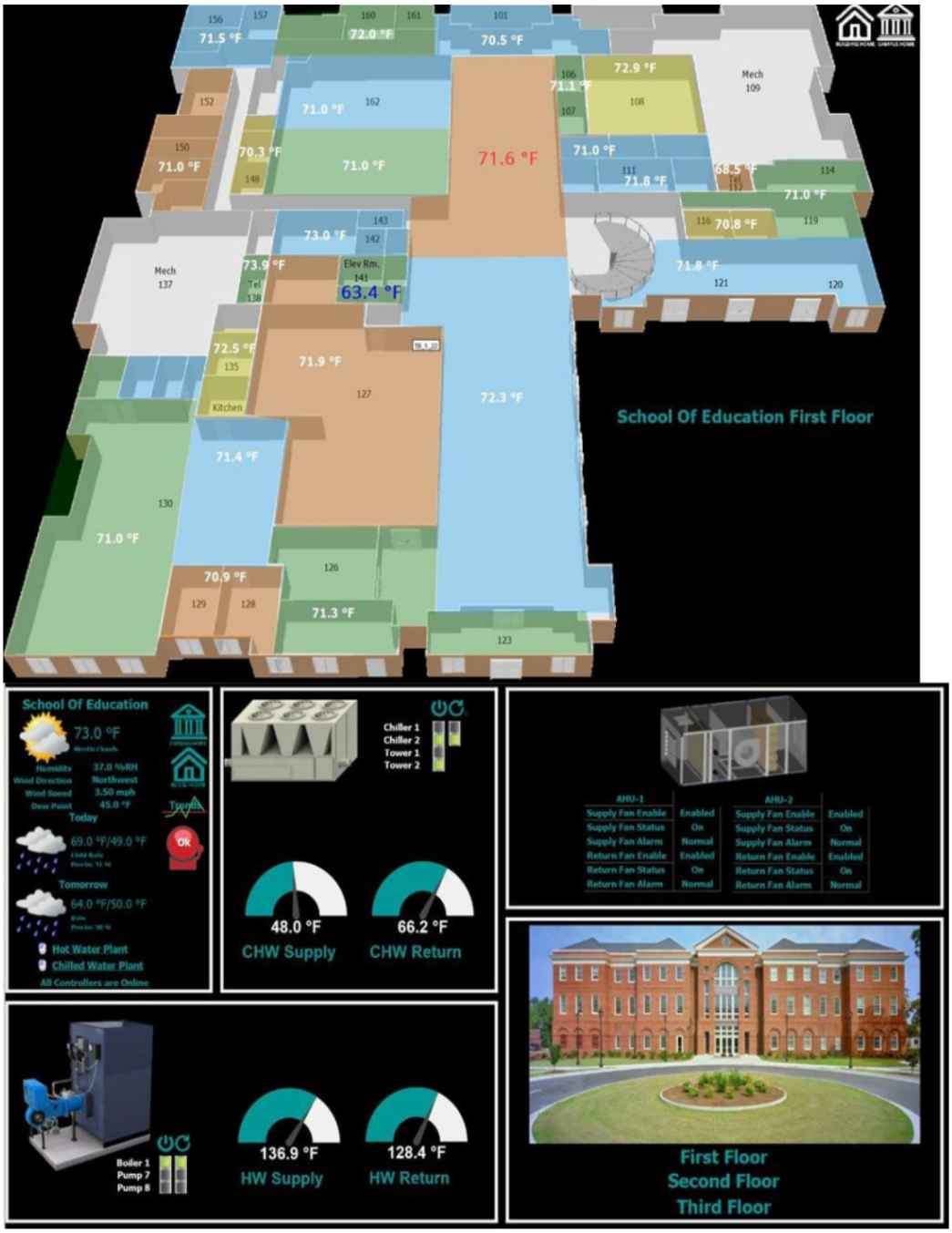
connected together to perform a specified sequence. A library of microblocks must be submitted with the control contractors bid.

4. Wires: Must be Graphical elements used to form logical connections between microblocks and between logical I/O.
5. Reference Labels: Labels must be similar to wires in that they are used to form logical connections between two points. Labels must form a connection by reference instead of a visual connection, i.e. two points labeled 'A' on a drawing are logically connected even though there is no wire between them.
6. Parameter: A parameter must be a value that may be tied to the input of a microblock.
7. Properties: Dialog boxes must appear after a microblock has been inserted which has editable parameters associated with it. Default parameter dialog boxes must contain various editable and non-editable fields, and must contain 'push buttons' for the purpose of selecting default parameter settings.
8. Icon: An icon must be graphic representation of a software program. Each graphic microblock has an icon associated with it that graphically describes its function.
9. Menu-bar Icon: Must be an icon that is displayed on the menu bar on the GPL screen, which represents its associated graphic microblock.
10. Live Graphical Programs: The Graphic Programming software must support a ' live' mode, where all input/output data, calculated data and set points must be displayed in a ' live' real-time mode.

2.10 WEB BROWSER GRAPHICAL USER INTERFACE

A. Color Graphics: The Web Browser GUI must make extensive use of color in the graphic pane to communicate information related to set points and comfort. Animated .gifs or .jpg, vector scalable, active set point graphic controls must be used to enhance usability. Graphics tools used to create Web Browser graphics must be non-proprietary and conform to the following basic criteria:

1. Display Size: The GUI workstation software must graphically display in a minimum of 1024 by 768 pixels 24-bit True Color.
2. General Graphic: General area maps must show locations of controlled buildings in relation to local landmarks.
3. Color Floor Plans: Floor plan graphics must be multi-colored to differentiate between the different zones and areas. Colors selected are based on a neutral palette as to not show a large variance in bright colors but more of a neutral, slightly different tones. Provide a visual display of temperature relative to their respective set points via the use of a color changing font and size that displays the zone temperature. The displayed temperature must change to a red blinking, size 20 font for high space temperature and blue blinking, size 20 font for low space temperature. The colors and font size must be updated as a zone's actual comfort condition changes from a normal range to a high or low out of range measurement.
4. General Graphic: A general first page for the building must be of a standard summary format showing vital information and links to the building’s operation and status. This PX page is named “overview” and is the first page to go to when accessing the building from the N4 Campus homepage.



2.11 LONWORKS NETWORK MANAGEMENT

A. Systems requiring the use of third-party LonWorks network management tools must not be accepted.

B. Network management must include the following services: device identification, device installation, device configuration, device diagnostics, device maintenance and network variable binding.

C. The Network configuration tool must also provide diagnostics to identify devices on the network, to reset devices and to view health and status counters within devices.

D. These tools must provide the ability to "learn" an existing LonWorks network, regardless of what network management tool(s) were used to install the existing network, so that existing LonWorks devices and newly added devices are part of a single network management database.

E. The network management database must be resident in the Site Network Controller (SNC), ensuring that anyone with proper authorization has access to the network management database at all times. Systems employing network management databases that are not resident, at all times and within the control system must not be accepted.

F. Color Graphics: The Web Browser GUI must make extensive use of color in the graphic pane to communicate information related to set points and comfort. Animated .gifs or .jpg, vector scalable, active set point graphic controls must be used to enhance usability. Graphics tools used to create Web Browser graphics must be non-proprietary and conform to the following basic criteria:
   1. Display Size: The GUI workstation software must graphically display in a minimum of 1024 by 768 pixels 24-bit True Color.
   2. General Graphic: A general first page for the building must be of a standard summary format showing vital information and links to the building's operation and status. This PX page is named "overview" and is the first page to go to when accessing the building from the N4 Campus homepage.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect 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 GENERAL

A. Install system and materials in accordance with manufacturer's instructions, and as detailed on the project drawing set.

B. Line and low voltage electrical connections to control equipment shown specified or shown on the control diagrams must be furnished and installed by the Control System Contractor in accordance with these specifications.

C. Equipment furnished by the Mechanical Contractor that is normally wired before installation must be furnished completely wired. Control wiring normally performed in the field will be furnished and installed by the Control System Contractor.

D. All control devices mounted on the face of control panels must be clearly identified as to function and system served with permanently engraved phenolic labels.

3.4 WIRING

A. All electrical control wiring to the control panels must be the responsibility of the Control System Contractor.

B. All wiring must be in accordance with the Project Electrical Specifications (Division 16), the National Electrical Code and any applicable local codes. All control wiring must be installed in raceways.

C. Excess wire must not be looped or coiled in the controller cabinet.

D. Incorporate electrical noise suppression techniques in relay control circuits.

E. There must be no drilling on the controller cabinet after the controls are mounted inside.

F. Careful stripping of wire while inside the cabinet is required to ensure that no wire strand fragments land on circuit boards.

G. Use manufacturer-specified wire for all network connections.

H. Use approved optical isolation and lightning protection when penetrating building envelope.

I. Read installation instructions carefully. Any unavoidable deviations must be approved by owner's rep prior to installation.

3.5 ACCEPTANCE TESTING

A. Upon completion of the installation, the Control System Contractor must load all system software and start-up the system. The Control System Contractor must perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these specifications.

B. The Control System Contractor must perform tests to verify proper performance of components, routines and points. Repeat tests until proper performance results. This testing must include a point-by-point log to validate 100% of the input and output points of the DDC system operation.

C. System Acceptance: Satisfactory completion is when the Control System Contractor has performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance must be contingent upon completion and review of all corrected deficiencies.

3.6 OPERATOR TRAINING

A. During system commissioning and at such time acceptable performance of the Control System hardware and software has been established, the Control System Contractor must provide on-site operator instruction to the owner's operating personnel. Operator instruction must be done during normal working hours and must be performed by a competent representative familiar with the system hardware, software and accessories.

B. The Control System Contractor must provide eight (8) total hours of comprehensive training in multiple sessions for system orientation, product maintenance and troubleshooting, programming and engineering. These classes are to be spread out during the 1st year warranty period. The first class starting after final commissioning and the last class is to be in the last month of 1-year warranty period.

3.7 WARRANTY PERIOD SERVICES

A. Equipment, materials and workmanship incorporated into the work must be warranted for a period of one year from the time of system acceptance.

B. Within this period, upon notice by the Owner, any defects in the BMS due to faulty materials, methods of installation or workmanship must be promptly repaired or replaced by the Control System Contractor at no expense to the Owner.

C. Maintenance of Computer Software Programs: The Control System Contractor must maintain all software during the standard first year warranty period. In addition, all factory or sub-vendor upgrades to software during the first-year warranty period must be added to the systems, when they become available, at no additional cost. In addition to first year standard warranty, software provided by Control System Contractor must come with a 1 Year Software Maintenance license. All SNC and BAS Servers are included in this coverage.

D. Maintenance of Control Hardware: The Control System Contractor must inspect, repair, replace, adjust, and calibrate, as required, the controllers, control devices and associated peripheral units during the warranty period. The Control System Contractor must then furnish a report describing the status of the equipment, problem areas (if any) noticed during service work, and description of the corrective actions taken. The report must clearly certify that all hardware is functioning correctly.

E. Service Period: Calls for service by the Owner must be honored within 24 hours and are not to be considered as part of routine maintenance.

F. Service Documentation: A copy of the service report associated with each owner-initiated service call must be provided to the owner.

3.8 WARRANTY ACCESS

A. The Owner must grant to the Control System Contractor reasonable access to the BMS during the warranty period. Remote access to the BMS (for the purpose of diagnostics and troubleshooting, via the Internet, during the warranty period) will be allowed.

3.9 OPERATION & MAINTENANCE MANUALS

A. See Division 1 for requirements. O&M manuals must include the following elements, as a minimum:
   1. As-built control drawings for all equipment.
   2. As-built Network Communications Diagram.
   3. General description and specifications for all components.
   4. Completed Performance Verification sheets.
   5. Completed Controller Checkout/Calibration Sheets.

3.10 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 230900

SECTION 231123 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping joining materials.
4. Manual gas shutoff valves.
5. Motorized gas valves.
6. Pressure regulators.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.

B. Natural-Gas System Pressure within Buildings: More than 0.5 psig but not more than 2 psig.

2.2 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. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.

2.3 PIPING SPECIALTIES

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.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

2.4 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

2.5 MANUAL GAS SHUTOFF VALVES

A. General Requirements for Metallic Valves: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Tamperproof Feature: Locking feature for valves indicated in "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
4. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
5. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

B. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Body: Bronze, complying with ASTM B584.
2. Ball: Chrome-plated bronze.
3. Stem: Bronze; blowout proof.
4. Seats: Reinforced TFE; blowout proof.
5. Packing: Threaded-body packnut design with adjustable-stem packing.
6. Ends: Threaded.
7. CWP Rating: 600 psig.
8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.6 MOTORIZED GAS VALVES

A. Electrically Operated Valves: Comply with UL 429.

1. Pilot operated.
2. Body: Brass or aluminum.
3. Seats and Disc: Nitrile rubber.
4. Springs and Valve Trim: Stainless steel.
5. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
6. NEMA ICS 6, Type 4, coil enclosure.
7. Normally closed.
8. Visual position indicator.

2.7 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 (DN 50) and smaller.

B. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Body and Diaphragm Case: Cast iron or die-cast aluminum.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
5. Orifice: Aluminum; interchangeable.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
8. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
9. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
10. Maximum Inlet Pressure: 2 psig.

PART 3 - EXECUTION

3.1 INDOOR PIPING INSTALLATION

A. Comply with NFPA 54 for installation and purging of natural-gas piping.

B. 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.

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. Locate valves for easy access.

E. Install piping free of sags and bends.

F. Install fittings for changes in direction and branch connections.

G. Verify final equipment locations for roughing-in.

H. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

I. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

J. Extend relief vent connections for line regulators to outdoors and terminate with weatherproof vent cap.

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, adjacent to each valve, at final connection to each piece of equipment.

N. Do not use natural-gas piping as grounding electrode.

O. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

3.2 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance.

B. Install regulators with maintenance access space adequate for servicing and testing.

3.3 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:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. 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.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration

B. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

C. Install hangers for steel piping, with maximum horizontal spacing and minimum rod diameter, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Support horizontal piping within 12 inches of each fitting.

3.5 CONNECTIONS

A. Install piping adjacent to appliances to allow service and maintenance of appliances.

B. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

C. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.6 LABELING AND IDENTIFYING

A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.

3.7 FIELD QUALITY CONTROL

A. Test, inspect, and purge natural gas according to NFPA 54 and authorities having jurisdiction.

B. Natural-gas piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.8 INDOOR PIPING SCHEDULE

A. Aboveground piping: Steel pipe with malleable-iron fittings and threaded joints.

3.9 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves: Two-piece, full-port, bronze ball valves with bronze trim

END OF SECTION 231123

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes pipe and fitting materials and joining methods for the following:

1. Steel pipe and fittings.
2. PVC pipe and fittings.
3. Copper tube and fittings.
4. Joining materials.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Pipe and tube.
2. Fittings.
3. Joining materials.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:

1. Hot-Water Heating Piping: 100 psig at 200 deg F.
2. Air-Vent Piping: 200 deg F.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.

B. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping: Schedule 40, Grade B steel pipe; Class 250, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

B. Makeup-water piping: Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints

C. Condensate-Drain Piping, PVC: Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.

D. 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.

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 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.

C. Install piping to permit valve servicing.

D. Install piping at indicated slopes.

E. Install piping free of sags and bends.

F. Install fittings for changes in direction and branch connections.

G. Install piping to allow application of insulation.

H. Select system components with pressure rating equal to or greater than system operating pressure.

I. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

J. 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.

K. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

L. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

M. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

N. Install valves according to the following:

1. Section 230523.13 "Butterfly Valves for HVAC Piping."
2. Section 230523.14 "Check Valves for HVAC Piping."

O. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

P. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.4 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

C. Install hangers for copper tubing and steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Support horizontal piping within 12 inches of each fitting and coupling

3.5 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 230553 "Identification for HVAC Piping and Equipment."

3.6 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to 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 shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety 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 shall not 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, "Building Services Piping."

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.

C. 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.

END OF SECTION 232113

SECTION 232116 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Air-control devices.
2. Strainers.
3. Connectors.

B. Related Requirements:

1. Section 230523.13 "Butterfly Valves for HVAC Piping" for specification and installation requirements for butterfly valves common to most piping systems.
2. Section 230523.14 "Check Valves for HVAC Piping" for specification and installation requirements for check valves common to most piping systems.

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.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 AIR-CONTROL DEVICES

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. Expansion Tanks:

1. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature, with taps in bottom of tank for tank fitting and taps in end of tank for gage glass. Tanks shall be factory tested after taps are fabricated and shall be labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless-steel ball check, 100-gal. unit only; sized for compression-tank diameter. Provide tank fittings for 125-psig working pressure and 250 deg F maximum operating temperature.
3. Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig working pressure and 240 deg F maximum operating temperature; constructed to admit air to compression tank, drain water, and close off system.
4. Gage Glass: Full height with dual manual shutoff valves, 3/4-inch-diameter gage glass, and slotted-metal glass guard.

C. 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. Air Vent: Threaded to the top of the separator.
3. Inline Inlet and Outlet Connections: Class 150 flanged.
4. Blowdown Connection: Threaded to the bottom of the separator.
5. Size: Match system flow capacity.

2.2 STRAINERS

A. Y-Pattern Strainers:

1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Flanged ends.
3. Strainer Screen: Stainless-steel, 40-mesh strainer, or perforated stainless-steel basket.
4. CWP Rating: 125 psig.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Install check valves at each pump discharge and elsewhere as required to control flow direction.

B. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

C. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.2 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping and elsewhere as required for system air venting.

B. Install air separator in pump suction. Install drain valve on air separators NPS 2 and larger.

C. Install expansion tanks on skid. 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

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SCOPE

A. Furnish and install variable speed pump control systems as required to provide a complete and satisfactory installation.

1.2 SUMMARY

A. Section Includes: Variable Speed Pump Package

1. Vertical Inline pumps.
2. Variable Frequency Drives.
3. TEFC motors.
4. Integral Controls Platform.

1.3 REFERENCES

A. HI: The Hydraulic Institute ANSI – American National Standards Institute.

B. NEMA: National Electrical Manufacturers Association.

C. UL: Underwriters Laboratories Inc.

D. ETL: Electrical Testing Laboratories.

E. CSA: Canadian Standards Association.

F. NEC: National Electrical Code.

G. ISO: International Standards Organization.

H. IEC: International Electrochemical Commission.

I. IEEE: Institute of Electrical and Electronic Engineers.

1.4 SUBMITTALS

A. Submittals must include the following:

1. System summary sheet

a. Sequence of operation

b. Shop drawings indicating dimensions, required clearances and location and size of each field connection.
c. Power and control wiring diagrams.
d. System profile analysis including variable speed pump curves and system curve. The analysis must also include job specific load profile and staging points.

B. Submittals must be specific to this project. Generic submittals will not be accepted.

1.5 QUALITY ASSURANCE

A. The pump control package must be fully assembled by the manufacturer. The manufacturer must be responsible for the complete pump control package, including system interface with pumps and VFDs, as well as the successful operation of all components supplied by the pump control system manufacturer.

B. All functions of the variable speed pump control system must be thoroughly field tested prior to actual start-up. This test must be conducted with motors connected to AFD output and it must test all inputs, outputs and program execution specific to this application.

C. Pump control package must be listed by Underwriter's Laboratories and bear the UL label.

1.6 DELIVERY STORAGE AND HANDLING

A. Delivery and Requirements:

1. Deliver material in accordance with Section 01 61 00 Common Product Requirements.

a. Deliver materials and components in manufacturer's original packaging with identification labels intact and in sizes to suit project.
b. Include manufacturer's name, job number, pump location, and pump model and series numbers on identification labels

B. Storage and Handling Requirements: Store materials off ground and protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer. Storage must be weather tight, rain proof, and dust proof.

1. Exercise care to avoid damage during unloading and storing.
2. Leave pump port protection plates in place until pumps are ready to connect to piping.
3. Do not place cable slings around pump shaft or integrated control enclosure.
4. Once installed the contractor must keep a dust proof cover over the drive, motor, and integral controller.

1.7 WARRANTY

A. Manufacturer's warranty: The entire package must carry an 18-month parts warranty. The drive will carry a parts and labor warranty. The motor will carry a 12-month parts and labor warranty but must be delivered to a local authorized motor warranty shop by the installing contractor.

Manufacturer's warranty is in addition to and not intended to limit other rights Owner may have under Contract Conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. The self-sensing product must consist of a factory prepackaged and preprogrammed pump, drive, motor, and integral controls package.

B. The drive must be mounted and integral to the motor. It must be mounted with rubber vibration mounts. The mounting and packing of the drive must be done in a manner that transmitted acceleration levels will be three times below the allowable limits published by the drive manufacturer. These limits will apply to a frequency range of 0-10,000 HZ.

C. The performance speed of this package must 1750 RPM nominal as standard. Exceptions for 3600 RPM will be noted in the schedules. 3600 RPM must NOT be an allowable substitution for a specified 1750 PRM package. 3600 RPM products might be considered as a substitution for 1750 RPM only if that manufacturer provides a spare motor, drive, and seal for each pumping unit.

D. Pump logic controller, variable frequency drives, sensor/transmitters and related equipment must be installed by the mechanical contractor as shown on the plans.

2.2 COMPONENTS

A. Pump Logic Controller.

1. The controller operation must operate the system using a tested and proven program that safeguards against undesirable or damaging conditions including:

    a. Motor overload.
    b. Pump flow surges.
    c. Hydraulic cycling (hunting).
    d. End of curve unstable operation: The pump logic controller, through a factory pre-programmed algorithm, must be capable of protecting the pumps from hydraulic damage due to operation beyond their published end-of-curve. This feature requires a flow meter for activation. The operator interface must include an owner adjustable flow setpoint to set the parameters for this routine.

2. The pump logic controller must be capable of starting, unloading, and stopping pumps based on a system performance program that will minimize energy consumption, provide reliable performance and bumpless transitions.

3. The integrated logic controller must be capable of running four different hydronic optimization sub-routines.

    a. Setup one: This subroutine must allow the pump package to track a quadratic system curve and will optimize a secondary distribution loop. It must use a

technology that allows the pump, drive, and motor package to translate the hydronic data from both a pump and system curve and translate it to electrical data. This allows the drive to know exactly where it is in the hydronic world.

i. Setup two: This subroutine must allow two pumps to run as backup for each other and must alternate the pumps based on a real time clock.
ii. Setup three: This subroutine must allow the package to run in a customer defined flow rate. The package will always seek to run at the user defined flow even with fouling causing system changes. It must use a technology that allows the pump, drive, and motor package to translate the hydronic data from both a pump and system curve and translate it to electrical data. This allows the drive to know exactly where it is in the hydronic world.
iii. Setup four: This subroutine must incorporate a traditional external sensing and control platform. It must allow the option of controlling the pumps with three zones of differential pressure or central plant differential temperature. This optional setup must allow the owner the option of external sensing without adding an external controller. This feature must be equal to Taco System Logic (TSL) or equal.

4. The control platform must include a subroutine equal or similar to the Taco Self-Sensing Series with ProBalance™. This subroutine must allow for the automatic balancing of secondary system distribution pumps. The package must automatically run system distribution pumps to a user defined duty point and will recognize that duty point and hold the pumps at a speed that matches the actual installed system quadratic system curve. The package will then use this data to set up a new duty point as the max point for the quadratic control curve. Use of external balancing devices or contractors will not be needed.

5. The package must serve as a flow metering device and will display pump flow at the user interface.

6. Must have optional ProView controller that automates pump balancing.

B. Pumps (See pump schedule on plans for exact model, type, and duty points.)

1. Vertical Close Coupled Pumps.

a. Pumps must be Taco Model KV or approved equal. The pumps must be single stage vertical inline design. The seal must be serviceable without disturbing the piping connections. The capacities and characteristics must be as called for in the plans/schedules.

i. Pump casing must be constructed of ASTM A48 class 30 cast iron. The pump casing/volute must be rated for 250 psi working pressure for all jobs. The pump flanges must be matched to suit the working pressure of the piping components on the job, with either ANSI Class 125 flanges or ANSI class 250 flanges. The pump casing must be drilled and tapped for gauge ports on both the suction and discharge connections and for a drain port at the bottom of the casing. The casing must have an additional tapping on the discharge connection to allow for the installation of a seal flush line. The pump cover must be drilled and tapped to accommodate a seal flush line

which can be connected to the corresponding tapping on the discharge connection, or to an external source to facilitate cooling and flushing of the seal faces.

ii. All casings must be flanged. Threaded casings not allowed unless extra unions and fittings are provided to allow servicing.

iii. The pump must have a factory installed vent/flush line to insure removal of trapped air from the casing and mechanical seal cooling. The vent/flush line must run from the seal chamber to the pump discharge.

iv. The pump must incorporate a dry shaft design to prevent the circulating fluid from contacting the shaft. The pump shaft must be AISI 1045 carbon steel with field replaceable bronze SAE 660 shaft sleeve. In order to improve serviceability and reduce the cost of ownership the shaft sleeve must be slip on (press on not allowable) and must be easily replaced in the field.

v. The pump must be fitted with a single mechanical seal, with EPT elastomers and Carbon/Ceramic faces, rated up to 250ºF. The mechanical seal must be an inside type seal. This seal must be capable of being flushed externally via a tapping in the pump cover adjacent to the seal cavity. The entire pump line must use no more than three different sizes of seals.

vi. Outside mechanical seals are NOT acceptable.

vii. The pump must be close coupled to a JM Frame, TEFC, inverter rated motor with class F insulation and shaft grounding ring.

viii. In order to both simplify and reduce the total cost of ownership; the manufacturer must standardize on no more than three sizes of mechanical seals throughout the entire range of the family of pumps. The manufacturer must not use multiple part numbers for the same part.

C. Variable Frequency Drives:

1. The VFD must convert incoming fixed frequency three-phase ac power into an adjustable frequency and voltage for controlling the speed of three-phase ac motors. The motor current must closely approximate a sine wave. Motor voltage must be varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor derating. When properly sized, the VFD must allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.
2. The VFD must include an input full-wave bridge rectifier and maintain a fundamental (displacement) power factor near unity regardless of speed or load.
3. The VFD must have a dual 5% impedance DC link reactor on the positive and negative rails of the dc bus to minimize power line harmonics and protect the VFD from power line transients. The chokes must be non-saturating. Swinging chokes that do not provide full harmonic filtering throughout the entire load range are not acceptable. VFDs with saturating (non-linear) dc link reactors must require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.
4. The VFD’s full load output current rating must meet or exceed NEC table 430-150. The VFD must be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 120% of rated torque for up to 0.5 second while starting.

5. The VFD must provide full motor torque at any selected frequency from 20 hz to base speed while providing a variable torque v/hz output at reduced speed. This is to allow driving direct drive fans without high speed derating or low speed excessive magnetization, as would occur if a constant torque v/hz curve was used at reduced speeds. Breakaway current of 160% must be available.
6. A programmable automatic energy optimization selection feature must be provided standard in the VFD. This feature must automatically and continuously monitor the motor's speed and load to adjust the applied voltage to maximize energy savings.
7. The VFD must be able to produce full torque at low speed to operate direct drive fans.
8. Output power circuit switching must be able to be accomplished without interlocks or damage to the VFD.
9. An automatic motor adaptation algorithm must measure motor stator resistance and reactance to optimize performance and efficiency. It must not be necessary to run the motor or de-couple the motor from the load to perform the test.
10. Galvanic isolation must be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog i/o and discrete digital i/o must include additional isolation modules.
11. VFD must minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency must be automatically adjusted to optimize motor and VFD operation while reducing motor noise. VFDs with fixed carrier frequency are not acceptable.
12. All VFDs must contain integral EMI filters to attenuate radio frequency interference conducted to the ac power line.
13. The drive enclosure must be standard as NEMA 12 (IP 55) and optional must be NEMA 4X (IP 66). See schedules for project requirements.
14. Protective features:

    a. A minimum of class 20 i2t electronic motor overload protection for single motor applications must be provided. Overload protection must automatically compensate for changes in motor speed.

        i. Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over voltage, under voltage, VFD over temperature and motor over temperature. The VFD must display all faults in plain language. Codes are not acceptable.
        ii. Protect VFD from input phase loss. The VFD should be able to protect itself from damage and indicate the phase loss condition. During an input phase loss condition, the VFD must be able to be programmed to either trip off while displaying an alarm, issue a warning while running at reduced output capacity, or issue a warning while running at full commanded speed. This function is independent of which input power phase is lost.
        iii. Protect from under voltage. The VFD must provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output, without faulting, with an input voltage as low as 70% of the nominal voltage.
        iv. Protect from over voltage. The VFD must continue to operate without faulting with a momentary input voltage as high as 130% of the nominal voltage.

v. The VFD must incorporate a programmable motor preheat feature to keep the motor warm and prevent condensation build up in the motor when it is stopped in a damp environment by providing the motor stator with a controlled level of current.

vi. VFD must include a "signal loss detection" algorithm with adjustable time delay to sense the loss of an analog input signal. It must also include a programmable time delay to eliminate nuisance signal loss indications. The functions after detection must be programmable.

vii. VFD must function normally when the keypad is removed while the VFD is running. No warnings or alarms must be issued as a result of removing the keypad.

viii. VFD must catch a rotating motor operating forward or reverse up to full speed without VFD fault or component damage.

ix. Selectable over-voltage control must be provided to protect the drive from power regenerated by the motor while maintaining control of the driven load.

x. VFD must include current sensors on all three output phases to accurately measure motor current, protect the VFD from output short circuits, output ground faults, and act as a motor overload. If an output phase loss is detected, the VFD will trip off and identify which of the output phases is low or lost.

xi. If the temperature of the VFD's heat sink rises to 80°c, the VFD must automatically reduce its carrier frequency to reduce the heat sink temperature. It must also be possible to program the VFD so that it reduces its output current limit value if the VFD's temperature becomes too high.

xii. In order to ensure operation during periods of overload, it must be possible to program the VFD to automatically reduce its output current to a programmed value during periods of excessive load. This allows the VFD to continue to run the load without tripping.

xiii. The VFD must have temperature-controlled cooling fan(s) for quiet operation, minimized losses, and increased fan life. At low loads or low ambient temperatures, the fan(s) may be off even when the VFD is running.

xiv. The VFD must store in memory the last 10 alarms. A description of the alarm, and the date and time of the alarm must be recorded.

xv. When used with a pumping system, the VFD must be able to detect no-flow situations, dry pump conditions, and operation off the end of the pump curve. It must be programmable to take appropriate protective action when one of the above situations is detected.

15. Internal Control Algorithm: This is a standard HVAC drive that has been upgraded and modified by pump experts for Hydronic applications. It is set up with a closed loop internal control sequence that will optimize life cycle, system comfort, and minimize energy consumption

16. Interface Features.

    a. Hand, off and auto keys must be provided to start and stop the VFD and determine the source of the speed reference. It must be possible to either disable these keys or password protect them from undesired operation.

i. There must be an “info” key on the keypad. The info key must include “on-line” context sensitive assistance for programming and troubleshooting.
ii. The VFD must be programmable to provide a digital output signal to indicate whether the VFD is in hand or auto mode. This is to alert the building automation system whether the VFD is being controlled locally or by the building automation system.
iii. Password protected keypad with alphanumeric, graphical, backlit display can be remotely mounted. Two levels of password protection must be provided to guard against unauthorized parameter changes.
iv. All VFDs must have the same customer interface. The keypad and display must be identical and interchangeable for all sizes of VFDs.
v. To set up multiple VFDs, it must be possible to upload all setup parameters to the VFD’s keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it must be possible to download from the keypad only size independent parameters. Keypad must provide visual indication of copy status.
vi. Display must be programmable to communicate in multiple languages including English, Spanish and French.
vii. A red fault light, a yellow warning light and a green power-on light must be provided. These indications must be visible both on the keypad and on the VFD when the keypad is removed.
viii. A quick setup menu with factory preset typical HVAC parameters must be provided on the VFD. The VFD must also have individual fan, pump, and compressor menus specifically designed to facilitate start-up of these applications.
ix. A four-feedback PID controller to control the speed of the VFD must be standard. This controller must accept up to four feedback signals. It must be programmable to compare the feedback signals to a common setpoint or to individual setpoints and to automatically select either the maximum or the feedback signal as the controlling signal. It must also be possible to calculate the controlling feedback signal as the average of all feedback signals or the difference between a pair of feedback signals.
x. The VFD must be able to apply individual scaling to each feedback signal.
xi. For fan flow tracking applications, the VFD must be able to calculate the square root of any or all individual feedback signals so that a pressure sensor can be used to measure air flow.
xii. The VFD’s PID controller must be able to actively adjust its setpoint based on flow. This allows the VFD to compensate for a pressure feedback sensor which is located near the output of the pump rather than out in the controlled system.
xiii. The VFD must have three additional PID controllers which can be used to control damper and valve positioners in the system and to provide setpoint reset.
xiv. Floating point control interface must be provided to increase/decrease speed in response to contact closures.
xv. Five simultaneous meter displays must be available. They must include at a minimum, frequency, motor current, motor voltage, VFD output power, VFD output energy, VFD temperature in degrees, among others.
xvi. Programmable sleep mode must be able to stop the VFD. When its output frequency drops below set “sleep” level for a specified time, when an

external contact commands that the VFD go into sleep mode, or when the VFD detects a no-flow situation, the VFD may be programmed to stop. When the VFD's speed is being controlled by its PID controller, it must be possible to program a "wake-up" feedback value that will cause the VFD to start. To avoid excessive starting and stopping of the driven equipment, it must be possible to program a minimum run time before sleep mode can be initiated and a minimum sleep time for the VFD.

xvii. A run permissive circuit must be provided to accept a "system ready" signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit must also be capable of initiating an output "run request" signal to indicate to the external equipment that the VFD has received a request to run.

xviii. VFD must be programmable to display feedback signals in appropriate units, such as inches of water column (in-wg), pressure per square inch (psi) or temperature (°F).

xix. VFD must be programmable to sense the loss of load and signal this condition via a keypad warning, relay output and/or over the serial communications bus. To ensure against nuisance indications, this feature must be based on motor torque, not current, and must include a proof timer to keep brief periods of no load from falsely triggering this indication.

17. Standard Control and Monitoring Inputs And Outputs.

a. Six dedicated, programmable digital inputs must be provided for interfacing with the systems control and safety interlock circuitry.

i. Two terminals must be programmable to act as either as digital outputs or additional digital inputs.

ii. Two programmable relay outputs, Form C 240 V AC, 2 A, must be provided for remote indication of VFD status.

iii. Each relay must have an adjustable on delay / off delay time.

iv. Two programmable analog inputs must be provided that can be either direct-or-reverse acting.

v. Each must be independently selectable to be used with either an analog voltage or current signal.

vi. The maximum and minimum range of each must be able to be independently scalable from 0 to 10 V dc and 0 to 20 mA.

vii. A programmable low-pass filter for either or both of the analog inputs must be included to compensate for noise.

viii. The VFD must provide front panel meter displays programmable to show the value of each analog input signal for system set-up and troubleshooting,

ix. One programmable analog current output (0/4 to 20 mA) must be provided for indication of VFD status. This output must be programmable to show the reference or feedback signal supplied to the VFD and for VFD output frequency, current and power. It must be possible to scale the minimum and maximum values of this output.

x. It must be possible through serial bus communications to read the status of all analog and digital inputs of the VFD.

xi. It must be possible to command all digital and analog output through the serial communication bus.

18. Optional Control And Monitoring Inputs And Outputs.

    a. It must be possible to add optional modules to the VFD in the field to expand its analog and digital inputs and outputs.

        i. These modules must use rigid connectors to plug into the VFD's control card.
        ii. The VFD must automatically recognize the option module after it is powered up. There must be no need to manually configure the module.
        iii. Modules may include such items as:
        iv. Additional digital outputs, including relay outputs
        v. Additional digital inputs
        vi. Additional analog outputs
        vii. Additional analog inputs, including Ni or Pt temperature sensor inputs
        viii. It must be possible through serial bus communications to control the status of all optional analog and digital outputs of the VFD.

19. Standard programmable firefighter's override mode allows a digital input to control the VFD and override all other local or remote commands. It must be possible to program the VFD so that it will ignore most normal VFD safety circuits including motor overload. The VFD must display firemode whenever in firefighter's override mode. Firemode must allow selection of forward or reverse operation and the selection of a speed source or preset speed, as required to accommodate local fire codes, standards and conditions.

20. A real-time clock must be an integral part of the VFD.

    a. It must be possible to use this to display the current date and time on the VFD's display.

        i. Ten programmable time periods, with individually selectable ON and OFF functions must be available. The clock must also be programmable to control start/stop functions, constant speeds, PID parameter setpoints and output relays. Is must be possible to program unique events that occur only during normal work days, others that occur only on non-work days, and others that occur on specific days or dates. The manufacturer must provide free PC- based software to set up the calendar for this schedule.
        ii. All VFD faults must be time stamped to aid troubleshooting.
        iii. It must be possible to program maintenance reminders based on date and time, VFD running hours, or VFD operating hours.
        iv. The real-time clock must be able to time and date stamp all faults recorded in the VFD fault log.

21. The VFD must be able to store load profile data to assist in analyzing the system demand and energy consumption over time.

22. The VFD must include a sequential logic controller to provide advanced control interface capabilities. This must include:

    a. Comparators for comparing VFD analog values to programmed trigger values.

i. Logic operators to combine up to three logic expressions using Boolean algebra.
ii. Delay timers.
iii. A 20-step programmable structure.

23. The VFD must include a cascade controller which allows the VFD to operate in closed loop setpoint (PID) control mode one motor at a controlled speed and control the operation of 3 additional constant speed motor starters.

24. Serial communications.

a. The VFD must include a standard eia-485 communications port and capabilities to be connected to the following serial communication protocols at no additional cost and without a need to install any additional hardware or software in the VFD:

i. Johnson Controls Metasys N2.
ii. Modbus RTU.
iii. Siemens FLN.
iv. BACnet MS/TP.
v. Optional communication must include:
LonWorks Free Topology (FTP)

b. VFD must have standard USB port for direct connection of Personal Computer (PC) to the VFD. The manufacturer must provide no-charge pc software to allow complete setup and access of the VFD and logs of VFD operation through the USB port. It must be possible to communicate to the VFD through this USB port without interrupting VFD communications to the building management system.
c. The VFD must have provisions for an optional 24 v DC back-up power interface to power the VFD's control card. This is to allow the VFD to continue to communicate to the building automation system even if power to the VFD is lost.

25. Adjustments.

a. The VFD must have a manually adjustable carrier frequency that can be adjusted in 0.5 khz increments to allow the user to select the desired operating characteristics. The VFD must also be programmable to automatically reduce its carrier frequency to avoid tripping due to thermal loading.

i. Four independent setups must be provided.
ii. Four preset speeds per setup must be provided for a total of 16.
iii. Each setup must have two programmable ramp up and ramp down times. Acceleration and deceleration ramp times must be adjustable over the range from 1 to 3,600 seconds.
iv. Each setup must be programmable for a unique current limit value. If the output current from the VFD reaches this value, any further attempt to increase the current produced by the VFD will cause the VFD to reduce its output frequency to reduce the load on the VFD. If desired, it must be possible to program a timer which will cause the VFD to trip off after a programmed time period.

v. If the VFD trips on one of the following conditions, the VFD must be programmable for automatic or manual reset: external interlock, under-voltage, over-voltage, current limit, over temperature, and VFD overload.
vi. The number of restart attempts must be selectable from 0 through 20 or infinitely and the time between attempts must be adjustable from 0 through 600 seconds.
vii. An automatic "start delay" may be selected from 0 to 120 seconds. During this delay time, the VFD must be programmable to either apply no voltage to the motor or apply a DC braking current if desired.
viii. Four programmable critical frequency lockout ranges to prevent the VFD from operating the load at a speed that causes vibration in the driven equipment must be provided. Semi-automatic setting of lockout ranges must simplify the set-up.

26. Optional features.

a. All optional features must be built and mounted by VFD manufacturer. All optional features must be UL listed by the VFD manufacturer as a complete assembly and carry a UL label.

i. All panels must be marked for their short circuit current rating in compliance with UL.

27. Service conditions.

a. Ambient temperature, continuous, full speed, full load operation:

i. 14 to 113°F through 125 HP @ 460 and 600 volt, through 60 HP @ 208 volt.
ii. 14 to 104°F 150 HP and larger.
iii. 0 to 95% relative humidity, non-condensing.
iv. Elevation to 3,300 feet without derating.
v. AC line voltage variation, -10 to +10% of nominal with full output.
vi. No side clearance must be required for cooling.
vii. All power and control wiring must be done from the bottom.
viii. All VFDs must be plenum rated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment in accordance with manufacturer's instructions and all applicable codes.

1. Ensure that pump is pipe-mounted and free to float with any movement, expansion and contraction of piping system.

a. Support pump using floor mounted saddle as required.

i. For vertical in-line pumps supported from structure, ensure no pipe strain is imposed on pump flanges.

2. Power wiring, as required, must be the responsibility of the electrical contractor. All wiring must be performed per manufacturer's instructions and all applicable codes.
3. Control wiring for remote mounted switches and sensor/transmitters must be the responsibility of the controls contractor. All wiring must be performed per manufacturer's instructions and all applicable codes.

B. Comply with HI 1.4.

C. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

D. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

E. Equipment Mounting:

1. Install skid-mounted pumps on cast-in-place concrete equipment bases.
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

3.2 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.

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 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.

3.4 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."

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's 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.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections. Hydronic pumps will be considered defective if they do not pass tests and inspections. Prepare test and inspection reports.

3.7 DEMONSTRATION

A. The control package manufacturer’s factory trained representative must provide start-up of the packaged pumping system. This start-up must include verification of proper installation, system initiation, adjustment and fine tuning. Start-up must not be considered complete until the sequence of operation, including all alarms, has been sufficiently demonstrated to the Owner or Owner’s designated representative. This jobsite visit must occur only after all hook-ups, tie-ins, and terminations have been completed and signed-off on the manufacturer’s start-up request form.

B. The pump control package manufacturer’s factory trained representative must provide on-site training for owner’s personnel. This training must fully cover maintenance and operation of all system components.

END OF SECTION 232123

SECTION 233118 - FACTORY-FABRICATED HYDRONIC PACKAGES

PART 1 - GENERAL

1.1 SUBMITTALS

A. Shop Drawings including but not limited to, the following:

1. Appropriate identification (for the package and each individual item).
2. Complete drawings showing plans and sections including details of construction.
3. Overall unit dimensions and individual components and sections dimensions.
4. Shipping and operation weight of unit and/or sections.
5. Structural design load.
6. Capacity/ratings.
7. Details of component support.
8. Materials of construction.
9. Pressure ratings and leakage ratings.
10. Each component manufacturer’s name, model number and data. (Refer to each component section for submittal requirements.)
11. Pressure drop calculation for all equipment and fittings in package.
12. Wiring diagrams and terminal points for control panels provided with units.
13. ETL, UL, ASME and ANSI certifications.
14. Manufacturer’s installation instructions.
15. All other appropriate data.
16. Hydronic package manufacturer’s local representative and phone number.

B. Drawings must be 1/4" scale plans (min), sections/elevations, and 3D CAD isometric views showing layouts and details of hydronic package base, assembled components, piping and pipe fittings, connection locations, electrical devices and wiring, supports, accessories and component manufacturer’s recommended maintenance clearances.

C. Manufacturer must provide a copy of the final approved CAD drawings to the designer for inclusion in the record documents.

1.2 DESIGN CRITERIA

A. Furnish hydronic package complete with pumps, piping, valves, piping specialties, vibration isolation, actuators, motors, variable frequency drives, power, and controls meeting configuration and as shown on drawings, specified and as scheduled. All unit components must meet this specification and requirements of referenced sections.

B. Contractor must immediately notify Designer of any change in size of the hydronic package dimensions as defined on the drawings made after Contracts are awarded. Additional costs due to these changes must be responsibility of this Contractor.

C. Hydronic package must be constructed as defined in the drawing to fit through all openings. Contractor must determine transport route and maximum section size with Owner prior to submitting shop drawings to determine critical dimensions.

D. All system components must have a minimum rating of 125 psig operating at 50°F temperatures, unless otherwise specified. All piping must be subjected to the hydrostatic test (at 10% below relief valve setting) after final assembly.

E. Hydronic packages must be field insulated by others. Unit layout and configuration must take into account insulation requirement for the project.

1.3 QUALITY ASSURANCE

A. This manufacturer must assume “Unit Responsibility” for the complete hydronic package. Unit responsibility must be defined as responsibility for the interface and successful operation of all components supplied by the manufacturer. The manufacturer must assemble the package. The manufacturer must be actively engaged in the design and fabrication of the packaged system being assembled.

B. The manufacturer must have dedicated and qualified service/startup division for all components provided as part of the packaged systems.

C. The manufacturer of the packaged system must be an authorized manufacturer’s representative or reseller for all major components of the packaged system.

D. Hydronic package must be ETL or other Nationally Recognized Testing Laboratory listed, certifying compliance with UL778, UL508, and UL508A standards as a complete package. This third-party product safety certification must apply to the complete package, including pumps, motors controls, wiring, valves and fittings, and safety devices as assembled into a complete package.

E. ASME Section IX certified welders must perform all welding of the piping.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Delivery: The Contractor upon receipt of the equipment must immediately verify that the equipment has not received damage during shipping and that all items listed on the bill of lading and the hydronic package manufacturer Shipping Documents are included in the shipment. If damage has occurred or if items are missing, the Contractor must note this on the manufacturer Shipping List before accepting delivery of the equipment.

B. Storage and Protection: Store equipment, and protect it from exposure to harmful weather conditions and at temperature conditions as recommended by manufacturer. See the manufacturer Equipment Storage Instructions included in the Operations and Maintenance Manual, and raw material and component manufacturer’s instructions and Operations and Maintenance Manuals.

C. The manufacturer must seal fluid and air openings prior to shipment. Blow all piping and equipment free of water. Piping and equipment damaged by freezing must be replaced, not repaired.

D. The manufacturer must deliver products to site with protective coverings and factory installed lifting lugs.

1.5 DOCUMENTATION

A. Provide the following information within the unit as it ships for contractor use:

1. As Built Electrical Drawings.
2. O&M Information including heat exchangers, pumps, control devices, pressure gauges, etc.
3. Factory test results.
4. Control Points List.
5. Unit Submittal.

1.6 WARRANTY

A. Hydronic packages and associated components must be warranted by the manufacturer for a period of one (1) years, from the date of final inspection and acceptance. The warranty must include all parts, labor (including travel), expenses and equipment necessary to perform replacement and/or repairs.

PART 2 - PRODUCTS

2.1 UNIT BASE

A. Unit base must be fabricated of 6” structural steel channel around unit perimeter and all section splits with additional structural members to support installed equipment. Break-formed shapes or channels in base will not be accepted.

B. Base design must be suitable for grouting of entire unit base.

C. Weld steel solid at connection points to assure rigidity. Size perimeter steel to allow for rigging and handling.

D. Locate and size base cross supports to support components, piping, and accessories. Break-formed cross supports will not be acceptable.

E. Each section must be equipped with a minimum of four permanently welded lifting lugs attached to perimeter base steel. Incorporate means of attaching cable or chain into each lug.

F. Base must be split in maximum size pieces to allow for economical shipment to jobsite and placement within building. Provide bolting structural steel on both sides of split for field joining.

G. Unit base must be primed and finished with rust inhibiting epoxy paint. Color is to be Industrial Grey.

H. All welding for the frame and piping must be performed by ASME Section IX certified welders, with certificates available upon request.

2.2 INTEGRAL VARIABLE SPEED PUMPS

A. For pump requirements, refer to Division 23 Section specifications.

B. Pump and motor must be provided as scheduled and meet requirements of appropriate specification sections.

2.3 BOILERS

A. For boiler requirements, refer to Division 23 specifications.

B. Boilers must be provided as scheduled and meet requirements of appropriate specification sections.

2.4 AIR ELIMINATION SYSTEM

A. For Air Control and Air Elimination refer to Division 23 specifications.

2.5 PIPING AND PIPING SPECIALTIES

A. For piping and piping specialties requirements, refer to Division 23 specifications.

B. All system piping connections must be piped to the frame edge of the package to facilitate installation.

2.6 DRAINS

A. The individual pump drain pans and blowdowns from the air and dirt separator and suction diffusers must be connected to a common drain line and piped to the edge of the hydronic package frame and provided with individual shutoff ball valves at each component. Other drains must be provided and piped as indicated in documents.

2.7 VALVES

A. For valves, refer to Division 23 specifications.

2.8 VARIABLE FREQUENCY DRIVES (VFD)

A. For variable frequency drive requirements, refer to Division 23 specifications.

2.9 INSTRUMENTATION

A. For instrumentation requirements, refer to Division 23 specifications.

B. Each pump must have a single pressure gauge piped across its suction diffuser inlet, pump suction and pump discharge. Gauges must be panel-mounted on the side of the package, and sensing lines must be 1/4" hard industrial grade copper tubing with soldered connections and secured directly to the skid. Each sensing line must be equipped with isolation ball valve (gauge cocks not permitted), and valves are to be located at the gauge panel for ease of use.

2.10 CONTROLS

A. Control devices must be by same manufacturer providing control devices for the remainder of the building.

B. Control devices, will be furnished by Contractor and must be factory installed as shown on plans and as described in control section of specifications.

C. Each system must be provided with a control panel in a NEMA 12 enclosure. Complete panel (not just components) must carry the UL label. Panel must include a through-the-door main disconnect, motor branch circuit breakers, hand-off-auto selector switches, pump "run" lights, control power transformer, terminal strips for external connections, and a variable time-based alternator to equal pump run time and other features as indicated. Terminal blocks must be provided for remote connection of controls by others.

1. Each motor controller within the control panel must be provided with individual overcurrent, short circuit and ground fault protection. Protective devices must be selected specifically for the motor served to satisfy all requirements of NEC Article 430. Protective devices (circuit breakers) must be located within main enclosure.
2. Equipment must have a short circuit rating equal to or greater than the available fault current at the point of connection. Equipment must be labeled with short circuit current rating. Where available fault current is not indicated elsewhere, provide 65kAIC rating.

D. Panel must be factory wired by a licensed electrician to each electrical device, utilizing liquid-tight conduit and connectors.

2.11 ELECTRICAL

A. Wiring and conduit on the hydronic package must be provided by package manufacturer meeting requirements of NEC and Division 26.

1. Provide single point of connection for hydronic package. Connection must be 460V, 3 Phase, 3 Wire + GND.

2.12 PAINTING

A. Each factory assembled packaged system, including all major components, must be thoroughly cleaned after fabrication is complete.

B. Entire package must be primed after cleaning.

C. After cleaning and priming, the package must be painted with two coats (min) of high-quality machinery grade enamel paint. Color must be Industrial Grey.

D. Nameplates of the components must not be painted over.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Unit manufacturer must provide and install all equipment within unit as specified including pumps, motors, piping, piping specialties, controls, electrical and all equipment necessary to provide a complete functional hydronic package. Mechanical and electrical connections (i.e., piping and conduit) must be available at the outside perimeter of the hydronic package so that appropriate Contractor may provide service to the hydronic package. Electrical wiring and control wiring must terminate in junction boxes/enclosures on accessible side of unit.

B. The contractor must set in place and anchor the hydronic package in accordance with the written recommendations of the manufacturer of the hydronic package. Hydronic package base with pre-aligned pumps must be installed level without stress. Pump alignment must be rechecked by the contractor.

C. The contractor must make all piping connections to the hydronic package's connections provided, all in accordance with the written recommendations of the manufacturer of the hydronic package. Piping connections must not allow piping stress to be transferred to the hydronic package during installation or operation.

D. Control wiring for remote mounted differential pressure switches, differential pressure transmitters, flow transmitters, start/stop commands, alarms etc. must be the responsibility of others. All control wiring must be performed per the current edition of the NEC (NFPA 70.)

3.2 START-UP

A. The manufacturer or factory trained representative must provide start-up of the hydronic package. This start-up must include verification of proper installation, system initiation, adjustment and fine tuning. This jobsite visit must occur only after all hook-ups, tie-ins, and terminations have been completed and signed-off on the manufacturer's start-up request form.

B. Remove Suction Diffuser Start-Up Strainer after system has been running for 48 hours.

3.3 CLEANING

A. Entire hydronic package must be thoroughly cleaned after installation.

3.4 TRAINING

A. The manufacturer or factory trained representative must provide on-site training for owner's personnel. Instruction includes 4 hours of training. This training must fully cover maintenance and operation of all system components. The manufacturer must have a complete HVAC training program available for this purpose.

END OF SECTION 233118

SECTION 235216 - CONDENSING BOILERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes gas-fired, fire-tube skid-mounted condensing boilers, trim, and accessories for generating hot water.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For boilers, boiler trim, and accessories.

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.

1.3 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period. Where "prorated" is indicated, the boiler manufacturer will cover the indicated percentage of cost of replacement parts. With "prorated" type, covered cost decreases as age of equipment increases.

1. Warranty Period for Fire-Tube Condensing Boilers:

a. The pressure vessel/heat exchanger shall carry a 10-year from shipment, non-prorated, limited warranty against any failure due to condensate corrosion, thermal stress, mechanical defects or workmanship.
b. The burner shall be conditionally guaranteed against any failure for (5) five years from shipment.

c. Manufacturer labeled control panels are conditionally warranted against failure for (3) three years from shipment.
d. All other components, with the exception of the igniter, flame detector and O_2 sensor, are conditionally guaranteed against any failure for (2) two years from shipment

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. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

C. DOE Compliance: Minimum efficiency shall comply with 10 CFR 431, Subpart E, Appendix N.

D. Mounting Base: For securing boiler to structural base.

2.2 SKID-MOUNTED, FORCED-DRAFT, FIRE-TUBE CONDENSING BOILERS

A. Description: Factory-fabricated, -assembled, and -tested, fire-tube, forced-draft, condensing boiler with heat exchanger sealed pressure tight, built on a steel base, including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Units are to be for water-heating service only.

B. Capacities and Characteristics: Refer to schedule on design drawings.

C. Primary Heat Exchanger: Stainless steel.

D. Secondary Heat Exchanger: Stainless steel.

E. Combustion Chamber and Flue Pipes: Stainless steel.

F. Pressure Vessel: Carbon steel with welded heads and tube connections.

G. Burner: Natural gas, forced draft.

H. Blower: Centrifugal fan to operate during each burner-firing sequence and to prepurge and postpurge the combustion chamber.

I. Gas Train: Combination gas valve with manual shutoff and pressure regulator.

J. Ignition: Direct-spark ignition or silicone carbide hot-surface ignition with 100 percent main-valve shutoff and electronic flame supervision.

K. Casing:

1. Jacket: Sheet metal, with snap-in or interlocking closures.
2. Control Compartment Enclosures: NEMA 250, Type 1A.
3. Finish: Baked-enamel or powder-coated protective finish.
4. Insulation: Minimum 2-inch-thick, mineral-fiber insulation surrounding heat exchanger.
5. Combustion-Air Connections: Inlet and vent duct collars.

2.3 TRIM - FOR HOT-WATER BOILERS

A. Include devices sized to comply with ASME B31.9.

B. Safety Relief Valve: ASME rated.

C. Pressure and Temperature Gauge: Combination water-pressure and -temperature gauge. Gauges shall have operating-pressure and -temperature ranges, so normal operating range is about 50 percent of full range.

D. High and low gas-pressure switches.

E. Alarm bell with silence switch.

F. Drain Valve: Minimum NPS 3/4 hose-end gate valve.

2.4 CONTROLS

A. The boiler electrical controls shall include the following devices and features:

1. Color touch screen control display factory mounted on the front cabinet panel door.

    a. The control display shall serve as a user interface for programming parameters, boiler control and monitoring; and shall feature a screen saver, alarm horn speaker, boiler status, configuration, history and diagnostics.

2. Integral controls power supply.
3. Flame safeguard control.
4. All standard controls shall be factory mounted and wired according to UL requirements.

B. Burner Operating Controls: To maintain safe operating conditions, factory mounted and wired burner safety controls limit burner operation:

1. High Limit: A manual reset mechanical Aquastat device shall stop the burner if operating conditions rise above maximum boiler design temperature.
2. Low-Water Cut Off: Electronic probe type mounted in the pressure vessel shall prevent burner operation on low water alarm.
3. Air Safety Switch: Prevent operation unless sufficient combustion air is proven.
4. Blocked Exhaust: Prevent operation in the event of a blocked flue gas exhaust stack.

C. Open-Loop O_2 Compensation: To maximize efficiency throughout seasonality:

1. Open-loop system shall use air density algorithms to automatically adjust the fuel/air ratio during operation, optimizing combustion reliability, flame stability, combustion efficiency, and the dewpoint temperature for formation of flue gas condensate.

2. O_2 monitoring-only systems that cannot automatically adjust combustion for seasonal variability shall not be accepted. Systems that trim but at less than a 100% duty cycle are unable to cope with rapid changes in operating conditions and shall not be accepted.

D. Boiler Operating Controls and Features:

1. Inlet Water Temperature Monitoring.
2. Combustion Air Temperature Monitoring.
3. Flue Gas Exhaust Temperature Monitoring: Sensor probe shall be stainless steel.
4. Proportional Integral Derivative (PID) temperature load control capability for hydronic hot water in standalone or lead/lag operation.
5. Operating temperature sensor for automatic start and stop.
6. Time of day display.
7. Customizable boiler name display.
8. Two customizable boiler interlock terminals displayed.
9. Alarm history for a minimum 100 most recent alarms including status at time of lockout.
10. Administrative password protection options.
11. Indirect domestic hot water priority.
12. Variable Speed System (Secondary) Pump Control:

    a. When installed in a variable primary flow configuration, the boiler controller shall provide the capability to control two variable speed hydronic heating pumps. One pump shall be duty, and one standby.
    b. The duty system pump shall be enabled upon the outdoor air temperature dropping below the warm weather shutdown temperature. Pumps shall be automatically rotated.
    c. Variable speed signal shall be provided to modulate pump speed according to hydronic heating loop Delta-T. A user selectable parameter allows for Delta-P in place of Delta-T.

13. Motorized isolation valve control:

    a. Upon heat demand for the boiler, the control shall provide an enable/open signal.
    b. After the burner is disabled and upon the heat exchanger delta-T dropping to a user programmable delta-T, the signal will be disabled.

        1) Boilers which utilize only a time delay close as the only means of valve actuation are unable to optimize for residual heat, and will not be accepted.

    c. In variable primary arrangements, the control shall hold the lead boiler isolation valve open at all times.

E. Lead/Lag Control of Modular (Multiple) Boiler Plants: Lead/Lag capabilities shall be integral to the boiler controller for up to 10 boilers installed in the same hydronic loop and shall not require an external panel.

1. The boiler manufacturer shall provide a supply water header temperature sensor.

a. The temperature sensor shall have tolerance according to IEC 60751, field installed in the common supply water piping.

2. Lead/lag operation shall not require a master boiler or external control panel. Field wired sensors or communication may be connected to any boiler in the lead/lag sequence.
3. The boilers shall communicate with each other via a private Ethernet/IP addressed network.

a. Field wiring between boilers shall be shielded Cat5e or Cat6 Ethernet cable.
b. In the event a communication cable becomes damaged or interrupted, communication shall be lost with only one boiler and not the entire lead/lag operation. Daisy chain style wiring lacks this redundancy and shall not be accepted.

4. Sequence of Operation:

a. Upon loop temperature dropping below start point, the lead boiler shall be enabled at low fire and shall modulate according to the heating demand.
b. Lag boiler stages are enabled according to heating demand. Boilers shall modulate in parallel as a cohesive unit according to heating demand.
c. When all available boilers are active they may modulate in parallel up to full fire according to the heating demand.
d. As heating demand decreases, the sequence shall operate in reverse.
e. Rotation of the lead and subsequent lag boilers shall be automatic.

F. Building Automation System Interface: Hardware and software to enable building automation system (BAS) to monitor, control, and display boiler status and alarms.

1. Hardwired Contacts:

a. Monitoring: Boiler Status, Burner Demand, General Alarm.
b. Control with Factory Installed Jumper: Safety Interlock for External Device, Remote Enable, Emergency Stop (E-Stop).
c. Remote Setpoint Signal: 4-20 mA or 0-10 VDC.

2. Communication Protocol: A communication interface with BAS shall enable BAS operator to remotely enable and monitor the boiler plant from an operator workstation.

a. The boilers will communicate with each other and the Building Automation System via a daisy chain addressed Modbus network. Field wiring between nodes shall be twisted pair low voltage with shielded ground.
b. A LonWorks protocol communication gateway shall be provided. The LonWorks gateway factory or field installed on boiler. Additional boilers in the lead/lag system shall not require a dedicated LonWorks gateway for the BAS to monitor status. A communication point mapping list shall be provided.

2.5 VENTING KITS

A. Kit: Complete system, ASTM A959, Type 29-4C stainless steel pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.

B. Combustion-Air Intake: Complete system, stainless steel pipe, vent terminal with screen, inlet air coupling, and sealant.

2.6 CONDENSATE-NEUTRALIZATION UNITS

A. Description: Factory-fabricated and -assembled condensate-neutralizing tank assembly of corrosion-resistant plastic material with threaded or flanged inlet and outlet pipe connections. Device functions to prevent acidic condensate from damaging grain system. It is to be piped to receive acidic condensate discharged from condensing boiler and neutralize it by chemical reaction with replaceable neutralizing agent. Neutralized condensate is then piped to suitable drain.

B. Tank features:

1. 5-gallon.
2. All corrosion-resistant material.
3. Suitable for use on all natural gas and propane boilers.
4. Includes initial charge of neutralizing agent.
5. Neutralizing agent to be easily replaceable when exhausted.
6. Inlet and outlet pipe connections.

C. Tank Configuration:

1. Top easily removed for neutralizing agent replacement.
2. Internal baffles to channel flow for complete neutralization.
3. Integral bypass to prevent condensate backflow into appliance.
4. Multiple units may be used for larger capacity.

2.7 SOURCE QUALITY CONTROL

A. UL Compliance: Test gas-fired boilers having input of more than 400,000 Btu/h for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

B. UL Compliance, Gas-Fired: Test gas-fired boilers for compliance with UL 2764. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

C. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

D. Test and inspect factory-assembled boilers, before shipping, in accordance with 2017 ASME Boiler and Pressure Vessel Code. Factory test boilers for safety and functionality; fill boiler with water, and fire throughout firing range, to prove operation of all safety components.

PART 3 - EXECUTION

3.1 BOILER INSTALLATION

A. Equipment Mounting:

1. Install skid-mounted boilers on factory-assembled packaged system.

B. Install gas-fired boilers according to NFPA 54.

C. Assemble and install boiler trim.

D. Install electrical devices furnished with boiler but not specified to be factory mounted.

E. Install control wiring to field-mounted electrical devices.

3.2 PIPING CONNECTIONS

A. Connect piping to boilers as part of the factory assembled packaged system.

B. Install condensate drain piping to condensate-neutralization unit and from neutralization unit to nearest floor drain. Piping shall be at least full size of connection. Install piping with a minimum of 2 percent downward slope in direction of flow.

C. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas-train connection. Provide a reducer if required.

D. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve, and union or

E. Install piping from safety relief valves to nearest floor drain.

3.3 DUCT CONNECTIONS

A. Boiler Venting:
1. Comply with all boiler manufacturer's installation instructions.
2. Field fabricate and install boiler vent and combustion-air intake.
3. Utilize vent and intake duct material, size, and configuration as indicated in boiler manufacturer's instructions and to comply with UL 1738.
4. Comply with all boiler manufacturer's installation instructions.
5. Connect boiler vent full size to boiler connections.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

3.5 FIELD QUALITY CONTROL

A. Testing Agency, Contractor: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Tests and Inspections:

1. Perform installation and startup checks in accordance with manufacturer's written instructions.
2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

    a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
    b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

D. Boiler will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. 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 boilers.

1. Instructor shall be factory trained and certified.
2. Provide not less than two 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 235216

SECTION 260500 - GENERAL ELECTRICAL

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. 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.

B. 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.

C. 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.

D. The work shall include, but not be limited to, furnishing, coordinating, and installing the following:

1. Electrical distribution system for power, and miscellaneous power as shown on the contract drawings.
2. Grounding.
3. Other special requirements and/or systems where shown.

E. 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.

F. All power interruptions to existing equipment shall be at the Owner’s convenience with 24 hours (minimum) notice. Each interruption shall have prior approval.

G. 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.

H. Field verify all existing underground electrical and mechanical piping.

1.2 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 specifications 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.

F. The project shall be bid based on the equipment listed in these specifications and on the drawings. After award of the Electrical 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 and working space clearly indicated.

1.3 COORDINATION OF WORK

A. 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.

B. 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.

C. Location of electrical raceways, switches, panels, 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.

D. 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 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. 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.

E. 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.

F. Where materials such as wiring devices and plates, fire alarm equipment, paging system components, etc. are specified to match existing, provide materials to match existing equipment in finish, color, capacity, ratings, operating characteristics, performance, etc.

G. Delivery and Storage: Equipment and materials shall be delivered to the site and stored in original containers, suitably sheltered from the elements, but readily accessible for inspection by the Architect/Engineer until installed.

H. Equipment and materials of the same general type shall be of the same make throughout the work to provide uniform appearance, operation and maintenance.

I. 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.

1.5 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.

1.6 PAINTING

A. All painting will be performed by the General Contractor for the project, unless specifically indicated otherwise.

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.

1.7 LOCATIONS AND MEASUREMENTS

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.

1.8 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.

1.9 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.

1.10 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 919-807-4111. Inspections shall be limited to Monday thru Friday unless specifically authorized by State Construction Office

1.11 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. Institute of Electrical and Electronic Engineers (IEEE)
6. Insulated Cable Engineers Association (ICEA)
7. International Code Council (ICC)
8. International Conference of Building Officials (ICBO)
9. National Electrical Code (NEC) 2017 edition
10. National Electrical Contractor's Association (NECA)
11. National Electrical Installation Standards (NEIS)
12. National Electrical Manufacturer's Association (NEMA)
13. National Electrical Safety Code (NESC)
14. National Fire Protection Association (NFPA)
15. North Carolina Energy Conservation Code, 2018 (NCECC)
16. North Carolina State Building Code (NCSBC)
17. North Carolina Construction Manual with GS as listed (NCCM)
18. Occupational Safety and Health Act (OSHA)
19. Requirements of the Americans with Disabilities Act (ADA), latest edition.
20. Underwriters Laboratories Inc (U.L.)
21. Southern Building Code Congress International (SBCCI)
22. Toxicity Characteristics Leaching Procedure (TCLP)

B. All electrical equipment and material shall be listed by an approved third party testing agency approved by the NCBCC and 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.

1.12 ENCLOSURE TYPES

Unless otherwise specified herein or shown on the Drawings, electrical enclosures shall have the following ratings:

1. NEMA 1 for dry, indoor locations.
2. NEMA 3R for outdoor locations, rooms below grade (including basements and buried vaults), “DAMP” and “WET” locations.
3. NEMA 4X for locations subject to corrosion when specifically noted.

1.13 CORROSION PROTECTION

All equipment and hardware subject to exposure to the elements and/or not installed in a conditioned space shall be fabricated of non-metallic materials, hot dip galvanized after fabrication or 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. Ferrous, rusted or corroded materials shall be replaced before final acceptance of the work.

1.14 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 obtain all necessary permits and inspections of electrical work.

C. The Electrical Contractor shall contact State Construction Office Electrical to schedule any and all required inspections. All inspections shall be limited to Monday thru Friday unless specifically authorized by the State Construction Office.

1.15 TESTS AND SETTINGS

A. Test all systems furnished under Division 26 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. 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.

C. 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.

D. 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.

E. 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.

F. Electrical Grounding System Tests: Provide documentation showing values of earth ground impedance for the system ground. See Specifications Section 260526 for testing requirements.

1.16 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.

1.17 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.

1.18 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 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 off-sets, 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 fittings 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.

1.19 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.

1.20 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. Panel schedule(s).
2. Control wiring diagram(s).
3. Lighting fixture schedule(s).
4. Branch circuit conduit and conductor sizes.
5. Lighting fixture, receptacle, and switch outlets, interconnections and homeruns with circuit identification.

1.21 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 and Structural 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.

1.22 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.

1.23 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.

1.24 ALTERNATE BIDS

Alternate bid items are described in 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 260500

SECTION 260519 - BUILDING WIRE AND CABLE

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Building wire and cable.

B. Wiring connectors and connections.

1.2 RELATED SECTIONS

A. Section 260533 - Conduit.

B. Section 260534 - Boxes.

C. Section 260553 - Identification.

1.3 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code.

B. NECA Standard of Installation (National Electrical Contractors Association).

1.4 SUBMITTALS

A. Product Data: Provide manufacturer's catalog information showing dimensions, ratings, colors, and configurations.

B. Test Reports: Indicate procedures and values obtained.

C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

1.6 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown. "Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Equipment".

1.7 PROJECT CONDITIONS

A. All wire and cable shall be installed in conduit. This includes all power wiring; fire alarm, sound and communications wire and cable (unless noted otherwise); HVAC control cable; etc.

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.

1.8 COORDINATION

A. Coordinate Work as agreed upon by design build contract.

PART 2 - PRODUCTS

2.1 BUILDING WIRE AND CABLE

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

F. VFC Cable:

1. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable.
2. Type TC-ER with oversized crosslinked polyethylene insulation, **spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire**, and sunlight- and oil-resistant outer PVC jacket.

2.2 WIRING CONNECTORS AND CONNECTIONS

A. 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.

B. 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 UL-approved insulating covers.

C. 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 “wirenuts” or 3M Company “Scotchlock”. “Push wire” type connectors are not acceptable.

D. “Sta-Kon” or other permanent type crimp connectors shall not be used for branch circuit connections.

E. Joints in stranded conductors shall be spliced by approved mechanical connectors and gum rubber tape or friction tape. Solderless mechanical connectors for splices and taps, provided with U.L approved insulating covers, may be used instead of mechanical connectors plus tape.

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 WIRING METHODS

A. Concealed Dry Interior Locations: Use only building wire in raceway.

B. Exposed Dry Interior Locations: Use only building wire in raceway.

C. Above Accessible Ceilings: Use only building wire in raceway.

D. Wet or Damp Interior Locations: Use only building wire in raceway.

E. Exterior Locations: Use only building wire in raceway.

F. Underground Installations: Use only building wire in raceway.

G. VFC Output Circuits: Type TC-ER cable with braided shield in raceway.

3.4 INSTALLATION

A. Install products in accordance with manufacturers instructions.

B. Route wire and cable as required to meet Project Conditions.

C. Install cable in accordance with the NECA “Standard of Installation”.

D. Use solid conductor for feeders and branch circuits 10 AWG and smaller, and Class B stranded for larger conductors.

E. Use conductor not smaller than 12 AWG for power and lighting circuits.

F. Use conductor not smaller than 14 AWG for fire alarm and control circuits.

G. Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet (23 m) or branch circuit homeruns longer than 50 feet.

H. Pull all conductors into raceway at same time.

I. Use suitable wire pulling lubricant for building wire 4 AWG and larger.

J. Neatly train and lace wiring inside boxes, equipment, and panelboards.

K. Clean conductor surfaces before installing lugs and connectors.

L. Identify wire and cable under provisions of Section 260553.

M. Identify each conductor with its circuit number or other designation indicated on Drawings.

N. Common neutral multiwire receptacle branch circuits are not permitted. Provide separate, individual neutral conductors for receptacle circuits.

3.5 FIELD QUALITY CONTROL

A. Inspect wire for physical damage and proper connection.

B. Measure tightness of bolted connections and compare torque measurements with manufacturer’s recommended values.

C. Verify continuity of each branch circuit conductor.

D. 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 retained onsite as part of the project record documents for review at time of final project inspection.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Grounding electrodes and conductors.

B. Equipment grounding conductors.

C. Grounding well components.

1.2 REFERENCES

A. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.

B. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (International Electrical Testing Association).

C. NFPA 70 - National Electrical Code.

1.3 SUBMITTALS FOR REVIEW

A. Product Data: Provide for grounding electrodes and connections.

1.4 SUBMITTALS FOR INFORMATION

A. Test Reports: Indicates overall resistance to ground and resistance of each electrode.

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 SUBMITTALS FOR CLOSEOUT

A. Project Record Documents: Record actual locations of components and grounding electrodes.

B. Certificate of Compliance: Indicate approval of installation by authority having jurisdiction.

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.

1.7 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. “Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Equipment”.

PART 2 -PRODUCTS

2.1 MECHANICAL CONNECTORS

Material: Cast bronze, brass, or plain malleable iron. Ground clamps shall not be fabricated from aluminum or any aluminum alloy.

2.2 WIRE

Material: Stranded copper sized per NEC requirements.

2.3 GROUNDING WELL COMPONENTS

A. Well Pipe: 8 inch NPS (DN200) by 24 inch (600 mm) long PVC pipe with belled end.

B. Well cover: Cast iron with legend “GROUND” embossed on cover.

PART 3 -EXECUTION

3.1 EXAMINATION

Coordination and Meetings: Verify existing conditions prior to beginning.

3.2 INSTALLATION

A. Quality Control: Manufacturer’s instructions shall be followed.

B. Provide bonding to meet Regulatory Requirements.

C. Provide separate, insulated conductor within each feeder and branch circuit raceway.

D. Equipment Grounding Conductor: The raceway system shall not be relied on for ground continuity. A green grounding conductor, properly sized per the NEC (Table 250-122) 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.

E. Equipment grounding continuity shall be maintained through flexible conduit as required in previous sections.

F. Grounding conductors shall be installed as to permit the shortest and most direct path from equipment to ground. 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.

G. 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.

H. Boxes with concentric, eccentric or over-sized knockouts shall be provided with bonding bushings and jumpers. The jumper shall be sized per the NEC and lugged to the box.

I. An equipment ground bus shall be installed in each panelboard for terminating equipment grounding conductors.

J. 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.

3.3 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4, or provide for qualified technicians to perform testing according to the manufacturer’s recommendations.

END OF SECTION 260526

SECTION 260529 - SUPPORTING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Conduit and equipment supports.

B. Anchors and fasteners.

1.2 REFERENCES

A. NECA - National Electrical Contractors Association.

B. ANSI/NFPA 70 - National Electrical Code.

1.3 SUBMITTALS

A. Product Data: Provide manufacturer's catalog data for fastening systems.

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, installation, and starting of Product.

1.4 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown. "Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Equipment".

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS

A. Materials and Finishes: Provide adequate corrosion resistance. See Specifications Section 260500, Para. 1.14 for additional hardware corrosion resistance requirements.

B. 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.

C. Anchors and Fasteners:
   1. Concrete Structural Elements: Use expansion anchors.
   2. Steel Structural Elements: Use beam clamps.

3. Concrete Surfaces: Use self-drilling anchors and expansion anchors.
4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts.
5. Solid Masonry Walls: Use expansion anchors.
6. Sheet Metal: Use sheet metal screws or bolts
7. Wood Elements: Use wood screws.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Provide anchors, fasteners, and supports in accordance with NECA "Standard of Installation".

C. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.

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.

H. In wet and damp locations use steel channel supports to stand cabinets and panelboards one inch (25 mm) off wall.

I. 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.

J. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Metal conduit.

B. Flexible metal conduit.

C. Liquidtight flexible metal conduit.

D. Electrical metallic tubing.

E. Nonmetallic conduit.

F. Surface Raceway

1.2 RELATED SECTIONS

A. Section 260534 - Boxes.

B. Section 260526 - Grounding and Bonding.

C. Section 260529 - Supporting Devices.

D. Section 260553 - Electrical Identification.

1.3 REFERENCES

A. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.

B. ANSI C80.3 - Electrical Metallic Tubing, Zinc Coated.

C. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.

D. ANSI/NFPA 70 - National Electrical Code.

E. NECA “Standard of Installation”.

F. NEMA TC2 - Schedule 40 PVC

G. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.4 DESIGN REQUIREMENTS

Conduit Size: ANSI/NFPA 70.

1.5 SUBMITTALS

A. Product Data: Provide for metallic conduit, flexible metal conduit, liquidtight flexible metal conduit, metallic tubing, nonmetallic conduit, fittings and conduit bodies.

1.6 PROJECT RECORD DOCUMENTS

A. Accurately record actual routing of conduits larger than 2 inches (51 mm).

1.7 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown. “Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Equipment”.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Accept conduit on site. Inspect for damage.

B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

C. Protect PVC conduit from sunlight.

1.9 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 CONDUIT REQUIREMENTS

A. Size: Conduit shall be sized in accordance with the latest edition of the NEC unless shown otherwise, with minimum conduit size being ½ inch, except homeruns minimum size shall be 3/4”. Flexible metal and 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.

B. All conduit will be provided with insulated throat.

C. Underground Installations:
   1. More than Five Feet from Foundation Wall: Use rigid steel conduit, intermediate metal conduit, plastic coated conduit, thickwall nonmetallic conduit and thinwall nonmetallic conduit.
   2. Within Five Feet from Foundation Wall: Use rigid steel conduit.
   3. In or Under Slab on Grade: Use rigid steel conduit, intermediate metal conduit, plastic coated conduit, thickwall nonmetallic conduit and thinwall nonmetallic conduit.
   4. Minimum Size: 1 inch (25 mm).

D. Outdoor Locations, Above Grade: Use rigid steel conduit.

E. In Slab Above Grade:
   1. Use rigid steel conduit.
   2. Maximum Size Conduit in Slab: 3/4 inch (19 mm).

F. Wet and Damp Locations: Use rigid steel conduit.

G. Dry Locations:
   1. Concealed: Use rigid steel conduit, intermediate metal conduit or electrical metallic tubing. EMT may be utilized as permitted by the NEC, with the following restrictions. EMT shall not be installed:
      a. where tubing, couplings, elbows and fittings would be in direct contact with the earth.
      b. underground (in/below slab-on-grade or in earth).
      c. any location outdoors where the tubing, etc., would be subjected to the elements.
      d. where subject to severe corrosive influence.
      e. where subject to severe physical damage.
   2. Exposed: Use rigid steel conduit or intermediate metal conduit.

2.2 METAL CONDUIT

A. Rigid Steel Conduit: ANSI C80.1.

B. Plastic-Coated Rigid Steel Conduit: ANSI C80.1, 40 mil PVC coating.

C. Intermediate Metal Conduit (IMC): Rigid steel.

D. Fittings and Conduit Bodies: ANSI/NEMA FB 1; material to match conduit with all steel fittings.

2.3 FLEXIBLE METAL CONDUIT

A. Description: Interlocked steel construction.

B. Fittings: ANSI/NEMA FB 1, steel.

2.4 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Description: Interlocked steel construction with PVC jacket.

B. Fittings: ANSI/NEMA FB 1, steel or nonmetallic type.

2.5 ELECTRICAL METALLIC TUBING (EMT)

A. Description: ANSI C80.3; galvanized tubing.

B. Fittings and Conduit Bodies: ANSI/NEMA FB 1; steel or malleable iron, compression type, insulated throat.

2.6 NONMETALLIC CONDUIT

A. Description: NEMA TC 2; Schedule 40 PVC.

B. Fittings and Conduit Bodies: NEMA TC 3.

2.7 ONE PIECE SURFACE METAL RACEWAY

A. The raceway shall be dual channel (one side for power and one side for data) with a base and cover factory assembled.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5.

C. A hand operated cutting tool shall be available for the base and cover to ensure clean, square cuts.

D. A full complement of fittings shall be available including but not limited to mounting clips and straps, couplings, flat, internal and external elbows, cover clips, tees, entrance fittings, conduit connectors and bushings. The covers shall be painted with an enamel finish, in to match the raceway. They shall overlap the raceway to hide uneven cuts. All fittings shall be supplied with a base where applicable.

E. Device boxes shall be available for mounting standard devices and faceplates. A device box shall be available in single- and multiple-gang configurations up to six-gang. They shall range in depth from 0.94" to 2.75" [23.88mm to 69.85mm]. Single-gang boxes shall allow for snap-on and fastener application. Extension boxes shall be available to adapt to existing standard flush switch and receptacle boxes. All device and fixture box covers shall be painted with an enamel finish, ivory in color to match the raceway cover.

F. The raceway manufacturer will provide a complete line of connectivity outlets and modular inserts for UTP/STP Fiber Optic, Coaxial and other cabling types with face plates and bezels to facilitate mounting. A complete line of preprinted station and port identification labels, snap-in icon buttons as well as write-on station identification labels shall be available.

G. Raceway shall be paintable to match adjacent colors.

H. Raceway shall be painted by Electrical Contractor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. 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.

B. Raceways shall be installed concealed in finished areas. Where construction does not permit concealed raceways and where indicated on the drawings, raceways shall be run exposed. 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.

C. 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.

D. Install conduit in accordance with NECA “Standard of Installation”.

E. Arrange conduit to maintain headroom and present neat appearance.

F. Maintain adequate clearance between conduit and piping.

G. Maintain 12 inch (300 mm) clearance between conduit and surfaces with temperatures exceeding 104 degrees F (40 degrees C).

H. Cut conduit square using saw or pipecutter and de-burr cut ends.

I. Bring conduit to shoulder of fittings; fasten securely.

J. Use conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

K. Install no more than equivalent of three 90-degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use factory elbows, or hydraulic one-shot bender, to fabricate bends in metal conduit larger than 2 inch size.

L. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.

M. Provide suitable fittings to accommodate expansion and deflection where conduit crosses, control and expansion joints.

N. Provide suitable pull string in each empty conduit except sleeves and nipples.

O. Use suitable caps to protect installed conduit against entrance of dirt and moisture.

P. The raceway system shall not be relied on for grounding continuity. Ground and bond conduit under provisions of Section 260526.

Q. Identify conduit under provisions of Section 260553.

R. 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.

S. Where concentric, eccentric or over-sized knockouts are encountered, a grounding type insulated bushing shall be provided.

T. Fasten conduit supports to building structure and surfaces under provisions of Section 260529.

U. Arrange supports to prevent misalignment during wiring installation.

V. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

W. Group related conduits; support using conduit rack. Construct rack using steel channel; provide space on each for 25 percent additional conduits.

X. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.

Y. Do not attach conduit to ceiling support wires.

Z. 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.

AA. The term "fittings" includes couplings, connectors, offsets, LBs, etc.

BB. No pressure cast (pot metal) fittings or conduit bodies shall be allowed.

CC. Outlets, junction, taps, etc., on exposed rigid metal conduit shall be cast metal conduit fittings or cast 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.

DD. EMT couplings and terminations shall be made utilizing steel-plated hexagonal compression connectors. No set screw or indented type fittings shall be utilized.

EE. EMT couplings and terminations shall be "concrete tight" where buried in masonry or concrete. EMT fittings, where installed in damp locations, shall be of the "raintight" type.

FF. Install nonmetallic conduit in accordance with manufacturer's instructions.

GG. 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.

HH. PVC schedule 40 shall not be used exposed or concealed in gypsum walls, but may be used in CMU walls.

II. IMC and GRC shall terminate with either a double locknut / bushing set, or in a threaded hub.

JJ. Conduit couplings for IMC, GRC and PVC shall be in accordance with the NEC.

KK. 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.

LL. Route conduit under slab from point-to-point.

MM. Where underground or underslab 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 plastic -coated rigid steel.

NN. 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.

OO. Service entrance raceways run inside building foundation walls shall be buried at least eighteen (18) inches below grade or encased with a minimum of two (2) inches of concrete on all sides. Concrete encasement shall extend to the service equipment for raceways exposed above grade in crawl spaces.

PP. Encased raceways shall be of a type approved by the NEC as “suitable for concrete encasement”.

QQ. 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.

RR. 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.

SS. Raceways run underground, internal to building foundation walls shall be of a type, and installed by a method approved by the NEC.

TT. Raceways that penetrate outside walls, ceilings from conditioned space or other similar condition shall be effectively sealed to prevent condensation from infiltrating humid air.

UU. 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.

VV. 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.

WW. 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.

XX. Conduits, JBs, Troughs, any enclosure when mounted outside on the walls, shall be off the walls by one inch.

YY. 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.

ZZ. 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.

END OF SECTION 260533

SECTION 260534 - BOXES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Wall and ceiling outlet boxes.

B. Pull and junction boxes.

1.2 RELATED SECTIONS

A. Section 262726 - Wiring Devices: Wall plates in finished areas.

B. Section 260529 – Supporting Devices.

1.3 REFERENCES

A. NECA - Standard of Installation.

B. NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies.

C. NEMA OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

E. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS FOR REVIEW

A. Product Data: Provide manufacturer’s catalog information showing dimensions and configurations.

1.5 SUBMITTALS FOR CLOSEOUT

A. Record actual locations and mounting heights of outlet, pull, and junction boxes on project record documents.

1.6 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Provide Products listed and classified by testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated. “Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Equipment”.

PART 2 - PRODUCTS

2.1 OUTLET BOXES

A. Sheet Metal Outlet Boxes (for interior conditioned spaces only): NEMA OS 1, galvanized steel.
   1. Junction, switch, receptacle and outlet boxes for interior use in 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. Sheet steel boxes shall be as manufactured by Appleton, Raco, Steel City or Spring City.
   2. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 2 inch (13 mm) male fixture studs where required.
   3. Concrete Ceiling Boxes: Concrete type.

B. Cast Boxes (for all exterior and exposed unconditioned spaces): NEMA FB 1, Type FD, cast feralloy. Provide gasketed cover by box manufacturer. Provide threaded hubs. Cast boxes shall be by Crouse-Hinds, Appleton, O. Z. Gedney or Killark.

2.2 PULL AND JUNCTION BOXES

Sheet Metal Boxes: NEMA OS 1, galvanized steel.

PART 3 - EXECUTION

3.1 EXAMINATION

Verify locations of outlets prior to rough-in.

3.2 INSTALLATION

A. Install boxes in accordance with NECA "Standard of Installation".

B. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.

C. 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 (3 m) 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 stamped steel bridges to fasten flush mounting outlet box between studs.

3.3 ADJUSTING

A. Adjust flush-mounting outlets to make front flush with finished wall material.

B. Install knockout closures in unused box openings.

3.4 CLEANING

A. Clean interior of boxes to remove dust, debris, and other material.

B. Clean exposed surfaces and restore finish.

END OF SECTION 260534

SECTION 260553 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Nameplates and labels.

B. Wire and cable markers.

C. Conduit markers.

D. Wiring device plates marking.

E. Underground warning tape.

1.2 REFERENCES

ANSI/NFPA 70 - National Electrical Code.

1.3 SUBMITTALS

A. Product Data: Provide catalog data for nameplates, labels, and markers.

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.

1.4 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown. "Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Equipment".

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, 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.

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 exposed conduit and raceways at ten foot minimum intervals with a 6 inch wide band in accordance with the color scheme outlined above. 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 marking pen.

2.4 WIRING DEVICE PLATES MARKING

A. Description:
1. 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.
2. Print circuit number on flag type plastic cable tie with a permanent marker (Sharpie, etc.)

and attach to conductors in outlet box. Flag shall be readily visible upon removal of device plate.

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 (150 mm) 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

Degrease and clean surfaces to receive nameplates and labels.

3.2 APPLICATION

A. Install nameplate parallel to equipment lines.

B. Secure nameplate to equipment front using self tapping stainless steel screws, lockwashers and acorn nuts as shown on the Drawings.

C. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

D. Install receptacle identification labels at top of each device plate, parallel to upper surface.

E. 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.

F. Update all existing panelboard directories where changes are made. Provide new panel schedule cards as required to maintain legibility.

G. Identify underground conduits using one underground warning tape per trench at 6 - 8 inches below finished grade.

H. Install adhesive backed labels and nameplates only when ambient temperature and humidity conditions for adhesive use are within range recommended by manufacturer.

END OF SECTION 260553

SECTION 260580 - EQUIPMENT WIRING SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

Electrical supply for, and connections to, equipment specified under other Divisions.

1.2 RELATED DIVISIONS AND SECTIONS

A. Division 23: Heating Ventilating and Air Conditioning.

B. Specification 260533 – Conduit.

C. Specification 260519 - Building Wire and Cable.

D. Specification 260534 – Boxes.

E. Specification 260526 - Grounding and Bonding.

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. Furnish products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown. “Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Equipment”.

C. 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 OTHER CONTRACTS

A. The Electrical Contractor shall provide a source of power for mechanical equipment shown on the Drawings. Provide pigtails, flexible connections, conductors, raceways, circuit breakers,

safety switches, receptacles, junction boxes, panelboards and/or wiring troughs as detailed in this section and/or as shown on the Drawings.

B. Safety switches, fuses, variable speed drives, magnetic motor starters, magnetic motor starter overload elements, control devices and sensors and control wiring and control raceways for such equipment will be provided and installed by the contractor 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 contractor providing the equipment. Coordinate and verify all electrical requirements, connections, phasing and rotation, overcurrent and overload protective device sizes with the Contractor providing the equipment or the Owner in the case of Owner-furnished equipment. See other specifications divisions for further explanation of contractor responsibility. Do not apply power to equipment without the permission of the contractor providing the equipment.

C. Mechanical (Division 23) Equipment.
   1. The Electrical Contractor shall furnish and install power wiring up to a defined termination point (see Contract Drawings) consisting of a junction box, trough, or a properly sized starter, variable frequency drive or fused safety disconnect switch for each item of equipment specified in the Mechanical Contract. The termination point shall be located adjacent to the associated equipment, unless equipment has built-in disconnects, in which case the Electrical Contractor shall bring his conductors to a junction box adjacent to the equipment, leaving sufficient marked conductor tails for extension by the Contractor providing the equipment. The Contractor providing the equipment shall make final connections from the junction box to the equipment.
   2. HVAC Control Panels, Control Equipment and Computers:
      a. The Electrical Contractor shall provide and install power wiring to the control panel(s) terminals or to a receptacle, as required. The Electrical Contractor shall provide sufficient electrical circuits from the fire alarm control panel to allow 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.
      b. All equipment less than 110 volt, all relays, actuators, timers, seven-day clocks, alternators, pressure, vacuum, float, flow, pneumatic-electric, and low voltage thermostats, thermals, remote selector switches, remote pushbutton stations, emergency break-glass stations, interlocking, safety switches beyond Electrical Contractor termination point 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 the Mechanical Contractor.
   3. Heat Tape: Electrical Contractor shall provide junction boxes or weatherproof, ground fault interrupting type duplex receptacles for heat tapes. See electrical drawings for locations and confirm exact locations and termination requirements with the Mechanical Contractor.
   4. Refer to Division 23 for additional detail concerning electrical connections to Division 23 equipment, specifically Specification 230511.

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. Install disconnect switches, controllers, control stations, and control devices as indicated.

G. Modify equipment control wiring with terminal block jumpers as indicated.

H. Provide interconnecting conduit and wiring between devices and equipment where indicated.

END OF SECTION 260580

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fuses.

1.2 REFERENCES

A. NFPA 70 - National Electric Code.

B. NEMA FU 1 - Low Voltage Cartridge Fuses.

1.3 SUBMITTALS

A. Product Data: Provide data sheets showing electrical characteristics including time-current curves.

1.4 PROJECT RECORD DOCUMENTS

A. Record actual fuse sizes.

1.5 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.6 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Furnish products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated. “Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Equipment”.

1.7 EXTRA MATERIALS

A. Provide no less than 10% of each fuse size and type installed, with a minimum of at least one set of three of each.

B. Provide one fuse puller.

PART 2 - PRODUCTS

2.1 FUSE REQUIREMENTS

A. Dimensions and Performance: NEMA FU 1, Class as specified or indicated.

B. Voltage: Provide fuses with voltage rating suitable for circuit phase-to-phase voltage.

C. UL Listed.

	Circuit Type	Fuse type
1.	Service Entrance and Feeder Circuits over 600Amp 200K Amp interrupting rating.	Class L
2.	Service Entrance and Feeder Circuits 600Amp or less 200K Amp interrupting rating.	Class RK1 or J
3.	Motor, Motor Controller and Transformer Circuits 200K Amp interrupting rating.	RK5

D. For individual equipment where fault current does not exceed 50KA use Class K5 fuses with 50KA interrupting rating.

E. Fusible safety switches with short-circuit withstand ratings of 100KA or 200KA require Class R or Class J rejection fuse block feature.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fuses in accordance with manufacturer’s instructions.

B. Install fuse with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fusible switches.

B. Nonfusible switches.

1.2 RELATED SECTIONS

A. Section 260529 – Supporting Devices.

B. Section 260553 – Electrical Identification.

C. Section 262813 – Fuses.

1.3 REFERENCES

A. NECA - Standard of Installation (published by the National Electrical Contractors Association).

B. NEMA FU1 - Low Voltage Cartridge Fuses.

C. NEMA KS1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

D. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (published by the International Electrical Testing Association).

E. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS FOR REVIEW

A. Product Data: Provide switch ratings and enclosure dimensions.

1.5 SUBMITTALS FOR CLOSEOUT

A. Record actual locations of enclosed switches in project record documents.

1.6 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.7 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. “Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Equipment”.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. Cutler Hammer.
2. General Electric.
3. Siemens.
4. Square D.

2.2 RATINGS

A. Service Conditions:
   1. Temperature: 104°F. (40°C.).
   2. Altitude: N/A.
   3. Terminal Rating: 75°C. minimum.

B. Minimum Integrated Short Circuit Rating: 10,000 amperes rms symmetrical, or as indicated.

2.3 FUSIBLE SWITCH ASSEMBLIES

A. Description: NEMA KS 1, Type HD with externally operable handle interlocked (defeatable) to prevent opening front cover with switch in ON position, enclosed load interrupter knife switch. Mechanisms shall be non-teasible, positive, quick make-quick break type. Handle lockable in ON or OFF position. Switches shall have handles whose positions are easily recognizable in the ON or OFF position.

B. Fuse clips: Designed to accommodate NEMA FU1, Class R fuses.

2.4 NONFUSIBLE SWITCH ASSEMBLIES

Description: NEMA KS 1, Type HD with externally operable handle interlocked (defeatable) to prevent opening front cover with switch in ON position, enclosed load interrupter knife switch. Mechanisms shall be non-teasible, positive, quick make-quick break type. Handle lockable in ON or OFF position. Switches shall have handles whose positions are easily recognizable in the ON or OFF position.

2.5 ENCLOSURES

A. Fabrication: NEMA KS 1.
   1. Interior Dry Locations: Type 1.
   2. Exterior Locations: Type 3R.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with NECA “Standard of Installation”.

B. Switches 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 260500, Paragraph 1.23 for additional requirements.

C. Install fuses in fusible disconnect switches serving Division 26 equipment.

D. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

3.2 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4, or provide for qualified technicians to perform testing according to the manufacturer’s recommendations.

END OF SECTION 262816