

PROJECT MANUAL

NEW HANOVER COUNTY GOVERNMENT CENTER

Wilmington, North Carolina



TENANT IMPROVEMENT - GMP SET
NOVEMBER 20, 2020



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LS3P Commission No. 7702-190810

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SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Work under Owner's separate contracts.
4. Owner-furnished/Owner-installed (OFOI) products.
5. Contractor's use of site and premises.
6. Coordination with occupants.
7. Work restrictions.
8. Specification and Drawing conventions.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.
2. Section 017300 "Execution" for coordination of Owner-installed products.

1.2 PROJECT INFORMATION

A. Project Identification: New Hanover County Government Center.

1. Project Location: Government Center Drive, Wilmington, North Carolina 28403.

B. Owner: Cape Fear FD Stonewater, 1051 Military Cutoff Road, Suite 200, Wilmington, North Carolina 28405.

1. Owner's Representative: Brian Eckel.

C. Architect: LS3P, 101 N. Third Street, Suite 500, Wilmington, North Carolina 28401; Phone: 910.790.9901.

1. Architect's Representative: Laura Miller, AIA, LEED AP.

D. Architect's Consultants: Architect has retained the following design professionals, who have prepared designated portions of the Contract Documents:

1. Plumbing: Newcomb & Boyd, Josh Desousa.
2. Fire Protection: Newcomb & Boyd, Evan Meredith
3. Mechanical: Newcomb & Boyd, Paul Kitchens.
4. Electrical: Newcomb & Boyd, Silas Khor.

E. Owner Consultants: Owner has retained the following design professionals who have prepared designated portions of the Contract Documents:

1. Civil: SEPI Engineering, Mark Arcuri.
2. Landscape: Mihaly Land Design, Josh Mihaly.
3. Structural: Citadel, Glenn Doncaster.

F. Construction Manager: Thomas Construction Group.

1. Construction Manager Representative: Chris Reid.

2. Construction Manager for this Project is Project's constructor. The terms "Construction Manager" and "Contractor" are synonymous.

G. Web-Based Project Software: Project software will be used for purposes of managing communication and documents during the construction stage.

1. See Section 013100 "Project Management and Coordination." for requirements for using web-based Project software.

1.3 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and includes, but is not limited to, the following:

1. Interior upfit for a four-story, approximately 110,000 SF office building containing offices and workspaces for various New Hanover County (NHC) departments, training and conference rooms, and multiple areas of customer service, and a two-story, approximately 26,000 SF hardened structure containing the Emergency Operations Center (EOC), 911 Center, and Hub.
2. Scope of Work includes fire protection, plumbing, mechanical, electrical, and other Work indicated in the Contract Documents.

B. Type of Contract:

1. Project will be constructed under a single prime contract.

1.4 WORK UNDER OWNER'S SEPARATE CONTRACTS

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

B. Concurrent Work: Owner will award separate contract(s) for the following construction operations at Project site. Those operations will be conducted simultaneously with Work under this Contract.

1. Building Signage: Coordinate schedule with Owner to have code required building signage installed prior to inspections by AHJ for Certificate of Occupancy.

1.5 OWNER-FURNISHED/OWNER-INSTALLED (OFOI) PRODUCTS

A. The Owner will furnish and install products indicated.

B. Owner-Furnished/Owner-Installed (OFOI) Products:

1. Residential appliances.

1.6 CONTRACTOR'S USE OF SITE AND PREMISES

A. Restricted Use of Site: Contractor shall have limited use of Project site for construction operations as indicated on Drawings by the Contract limits and as indicated by requirements of this Section.

B. Limits on Use of Site: Limit use of Project site to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

1. Driveways, Walkways and Entrances: Keep driveways and entrances serving premises clear and available to Owner and New Hanover County, New Hanover County employees and visitors, and emergency vehicles at all times. Do not use these areas for parking or for storage of materials.
 - a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
 - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

1.7 COORDINATION WITH OCCUPANTS

- A. Partial Occupancy: New Hanover County will occupy the premises, including, but not limited to, adjacent buildings and parking lots, during entire construction period, with the exception of areas under construction. Cooperate with New Hanover County during construction operations to minimize conflicts and facilitate the County's usage. Perform the Work so as not to interfere with Owner's operations. Maintain existing exits unless otherwise indicated.
 1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and authorities having jurisdiction.
 2. Provide not less than 72 hours' notice to Owner and New Hanover County of activities that will affect the County's operations.

1.8 WORK RESTRICTIONS

- A. Comply with restrictions on construction operations.
 1. Comply with limitations on use of public streets, work on public streets, rights of way, and other requirements of authorities having jurisdiction.
- B. On-Site Work Hours: Limit work to between 7:00 a.m. to 7:00 p.m., Monday through Friday, unless otherwise indicated. Work hours may be modified to meet Project requirements if approved by Owner, New Hanover County, and authorities having jurisdiction.
 1. Weekend Hours: 7:00 a.m. - 5:00 p.m.
 2. Early Morning Hours: Comply with City of Wilmington's noise ordinance.
 3. Hours for Utility Shutdowns: 5:00 p.m. - 7:00 a.m. Monday through Friday. Must be coordinated with New Hanover County in advance.
- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by New Hanover County or others unless permitted under the following conditions and then only after arranging for temporary utility services according to requirements indicated:
 1. Notify Owner and New Hanover County not less than two days in advance of proposed utility interruptions.
 2. Obtain New Hanover County's written permission before proceeding with utility interruptions.
- D. Noise, Vibration, Dust, and Odors: Coordinate operations that may result in high levels of noise and vibration, dust, odors, or other disruption to New Hanover County occupancy with Owner and New Hanover County.
 1. Notify Owner and New Hanover County not less than two days in advance of proposed disruptive operations.
 2. Obtain New Hanover County's written permission before proceeding with disruptive operations.
- E. Smoking and Controlled Substance Restrictions: Use of tobacco products, alcoholic beverages, and other controlled substances on Owner's property is not permitted.

- F. Pandemic Restrictions:
1. Workers shall wear face masks at all times while in the building.
 - a. Face masks are not required for workers when working outside and socially distancing.
 2. Workers shall practice social distancing guidelines as outlined by the CDC, WHO, and NC DHHS.
- G. Employee Conduct: Workers shall conduct themselves in a business-like manner at all times.
1. The following will not be allowed:
 - a. Loud radios.
 - b. Guns or weapons.
 - c. Drugs or alcohol.
 - d. Harassment of any kind, including catcalls, foul language or other offensive language, gestures or other objectionable behavior.
 2. All employees must wear proper attire at all times. Shirts and shoes are required. T-shirts are acceptable provided they contain no objectionable graphics or text.

1.9 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.

1.2 DEFINITIONS

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents.
1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required to meet other Project requirements but may offer advantage to Contractor or Owner.

1.3 ACTION SUBMITTALS

- A. Substitution Requests: Submit documentation identifying product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
1. Substitution Request Form: Use form provided in Project Manual.
 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.
 - b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - e. Samples, where applicable or requested.
 - f. Certificates and qualification data, where applicable or requested.
 - g. List of similar installations for completed projects, with project names and addresses as well as names and addresses of architects and owners.
 - h. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.
 - i. Research reports evidencing compliance with building code in effect for Project.
 - j. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 - k. Cost information, including a proposal of change, if any, in the Contract Sum.

- l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
 - m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
 3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor through Construction Manager of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
 - a. Forms of Acceptance:
 - 1) During Bid Phase: Addenda.
 - 2) During Construction: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
 - b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.4 QUALITY ASSURANCE

- A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.5 PROCEDURES

- A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

1.6 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
 1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
 - a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - b. Substitution request is fully documented and properly submitted.
 - c. Requested substitution will not adversely affect Contractor's construction schedule.
 - d. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - e. Requested substitution is compatible with other portions of the Work.
 - f. Requested substitution has been coordinated with other portions of the Work.
 - g. Requested substitution provides specified warranty.
 - h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- B. Substitutions for Convenience: Not allowed.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500

REQUEST FOR SUBSTITUTION

Project: New Hanover Co. Government Center
To: LS3P
Wilmington, NC
Attn.: Laura Miller
Phone: 910-790-9901
Fax: 910-790-3301
Email: lauramiller@ls3p.com

Project No.: 7702-190810
Specification Section #: _____
Contractor: _____
Requested by: _____
Phone: _____
Fax: _____
Email: _____

Reason for not providing specified item: _____

Savings to Owner for accepting substitution: _____

Specified Product/Fabrication Method

(List name/description; model no.; manufacturer): _____

Required Information for **Specified** Product:

Point by Point Comparative Product Data

Tests

Reports

Fabrication Drawings

Samples (Where Applicable)

Attached:

☐☐☐☐☐

Proposed Product/Fabrication Method

(List trade name/description; model no.; manufacturer): _____

Required Information for **Proposed** Product:

Point by Point Comparative Product Data

Tests

Reports

Fabrication Drawings

Samples (Where Applicable)

Attached:

☐

(Required)

☐☐☐☐

List of Related Changes/Modifications: _____

Differences between proposed substitution
and specified product: _____

Proposed product/fabrication method

affects other parts of the Work

☐

No

☐

Yes: Explain

REQUEST FOR SUBSTITUTION

Undersigned certifies:

- Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product as utilized for this project, except as noted herein.
- Qualifications of manufacturer, installer, and other specified parties meet the specified qualifications.
- Same special warranty will be furnished for proposed substitution as for specified product.
- Same maintenance service and source for replacement parts, as applicable, is available as that specified.
- Proposed substitution does not affect dimensions and functional clearances, except as noted herein.
- Proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
- Failure of proposed substitution to produce indicated results will not be considered grounds for additional payment or time.

For the Contractor:

Submitted by: _____
Signed: _____
Firm: _____
Telephone: _____
Fax: _____
Email: _____

For the Manufacturer:

Submitted by: _____
Signed: _____
Firm: _____
Telephone: _____
Fax: _____
Email: _____

END OF REQUEST FOR SUBSTITUTION

SECTION 012600 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 MINOR CHANGES IN THE WORK

- A. Architect will issue through Construction Manager supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710.

1.3 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: Construction Manager will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
 - 1. Work Change Proposal Requests issued by Construction Manager are not instructions either to stop work in progress or to execute the proposed change.
 - 2. Within time specified in Proposal Request or 20 days, when not otherwise specified, after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
 - a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - c. Include costs of labor and supervision directly attributable to the change.
 - d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
 - e. Quotation Form: Use form included in Project Manual.
- B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Construction Manager.
 - 1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
 - 2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - 3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - 4. Include costs of labor and supervision directly attributable to the change.
 - 5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
 - 6. Comply with requirements in Section 012500 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.

7. Proposal Request Form: Use form included in Project Manual.

1.4 CHANGE ORDER PROCEDURES

- A. On Owner's approval of a Work Change Proposal Request, Construction Manager will issue a Change Order for signatures of Owner and Contractor on AIA Document G701.
- B. The cost of the Contractors overhead and profit on any change order shall be:
1. For extra Work completed by the Contractor with his own labor, not more than 15 percent shall be added as the allowance for overhead and profit.
 2. For extra Work completed by Subcontractors of the Contractor, not more than 10 percent shall be added as the allowance for overhead and profit.
 3. For Work deleted which would have been completed by the Contractor, with his own labor, not less than 10 percent shall be credited to the Owner as the allowance for overhead and profit.
 4. For Work deleted which would have been completed by Subcontractors of the Contractor, not less than 5 percent shall be credited to the Owner by the Contractor as the allowance for overhead and profit.
- C. In order to facilitate checking of quotations for extras or credits, proposals, except those so minor that their propriety can be seen by inspection, shall be accompanied by a complete itemization of costs including labor, materials, and Subcontracts. Labor and materials shall be itemized in the manner prescribed above. Where major cost items are Subcontracts, they shall be itemized also. In no case will a change be approved without such itemization.

1.5 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Change Directive: Construction Manager may issue a Construction Change Directive on AIA Document G714. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.
- B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.
1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012600

CHANGE PROPOSAL WORKSHEET SUMMARY

New Hanover County Government Center
LS3P Project No.: 7702-190810

Cape Fear FD Stonewater, Owner
Contract Document Date: _____, 20____
Bulletin No. _____, Date: _____, 20____

A. NOTICE TO CONTRACTOR

1. Use this form as a cover sheet and summary for costs associated with Construction Change Directives, Requests for Proposal, and Change Orders. Use one form for Contractor, and a form for each subcontractor. Indicate allowable overhead and profit for Contractor, subcontractors, and sub-subcontractors in accordance with the Conditions of the Contract.

B. MATERIALS

1. Direct Cost of Materials \$ _____
a) Attach list with quantity, item, unit cost, unit manhours, total manhours, OT manhours, total cost.
2. Overhead and Profit on Item B.1. \$ _____
a) Include ____% max. for small tools & consumables
3. Sales Tax \$ _____
4. Shipping and Transportation \$ _____
5. Materials Subtotal \$ _____

C. LABOR

1. Direct Cost of Labor: Hours: _____ @ _____ /hr. \$ _____
a) Include time sheets if requested.
2. Overhead and Profit on Item C.1. \$ _____
a) Show O & P percentage on straight labor cost, not on premium portion.
b) O & P includes supervisor's time.
3. Payroll Taxes and Insurance @ _____ % \$ _____
4. Labor Subtotal \$ _____

D. EQUIPMENT RENTAL

1. Equipment Rental \$ _____
a) Include quotes and pick-up/delivery tickets.
2. Overhead and Profit on Item D.1. (____% maximum) \$ _____
3. Equipment Rental Subtotal \$ _____

E. SUBCONTRACTORS

1. Subcontractors \$ _____
a) Include quotes with material and equipment back up
2. Overhead and Profit on Item E.1. (____% maximum) \$ _____
3. Subcontractor Subtotal \$ _____

F. SUBTOTAL OF PROPOSAL

1. Bonds (____% of Subtotal of Proposal) \$ _____

G. TOTAL OF CHANGE PROPOSAL

\$ _____

CHANGE PROPOSAL WORKSHEET SUMMARY

H. TIME EXTENSION REQUEST:

1. Number of Days: _____ Schedule Activity # Affected: _____
2. Number of Days: _____ Schedule Activity # Affected: _____
3. Number of Days: _____ Schedule Activity # Affected: _____
4. Total Number of Days, this Proposal: _____

I. CONTRACTOR'S SIGNATURE:

1. Contractor: _____
Company Name
2. Prepared By: _____
Name
3. Date: _____

J. ATTACHMENTS:

SECTION 012900 - PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.
- B. Related Requirements:
 - 1. Section 012600 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
 - 2. Section 013200 "Construction Progress Documentation" for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.

1.2 DEFINITIONS

- A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.3 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.
 - 1. Coordinate line items in the schedule of values with items required to be indicated as separate activities in Contractor's construction schedule.
 - 2. Submit the schedule of values to Architect through Construction Manager at earliest possible date, but no later than seven days before the date scheduled for submittal of initial Applications for Payment.
 - 3. Subschedules for Separate Elements of Work: Where the Contractor's construction schedule defines separate elements of the Work, provide subschedules showing values coordinated with each element.
- B. ""Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section.
 - 1. Identification: Include the following Project identification on the schedule of values:
 - a. Project name and location.
 - b. Owner's name.
 - c. Name of Architect.
 - d. Architect's Project number.
 - e. Contractor's name and address.
 - f. Date of submittal.
 - 2. Arrange schedule of values consistent with format of AIA Document G703.
 - 3. Arrange the schedule of values in tabular form, with separate columns to indicate the following for each item listed:
 - a. Related Specification Section or division.
 - b. Description of the Work.
 - c. Name of subcontractor.
 - d. Name of manufacturer or fabricator.
 - e. Name of supplier.

- f. Change Orders (numbers) that affect value.
- g. Dollar value of the following, as a percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent. Round dollar amounts to whole dollars, with total equal to Contract Sum.
 - 1) Labor.
 - 2) Materials.
 - 3) Equipment.
- 4. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.
- 5. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
 - a. Differentiate between items stored on-site and items stored off-site.
- 6. Overhead Costs, Proportional Distribution: Include total cost and proportionate share of general overhead and profit for each line item.
- 7. Temporary Facilities: Show cost of temporary facilities and other major cost items that are not direct cost of actual work-in-place as separate line items.

1.4 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments, as certified by Architect and Construction Manager and paid for by Owner.
- B. Payment Application Times: The date for each progress payment is indicated in the Owner/Contractor Agreement. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.
 - 1. Submit draft copy of Application for Payment seven days prior to due date for review by Architect.
 - 2. Pay applications not submitted on time will not be paid until the following month.
- C. Application for Payment Forms: Use AIA Document G702 and AIA Document G703 as form for Applications for Payment.
- D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Construction Manager will return incomplete applications without action.
 - 1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
 - 2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
 - 3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
 - 4. Indicate separate amounts for work being carried out under Owner-requested project acceleration.
- E. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment for stored materials.
 2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
 3. Provide summary documentation for stored materials indicating the following:
 - a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
 - b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
 - c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.
- F. Transmittal: Submit five signed and notarized original copies of each Application for Payment to Construction Manager by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.
1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.
- G. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from entities lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.
1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
 2. When an application shows completion of an item, submit conditional final or full waivers.
 3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
 4. Submit final Application for Payment with or preceded by conditional final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
 5. Waiver Forms: Submit executed waivers of lien on forms acceptable to Owner.
- H. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
1. List of subcontractors.
 2. Schedule of values.
 3. Contractor's construction schedule (preliminary if not final).
 4. Products list (preliminary if not final).
 5. Submittal schedule (preliminary if not final).
 6. List of Contractor's staff assignments.
 7. List of Contractor's principal consultants.
 8. Copies of building permits.
 9. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
 10. Initial progress report.
 11. Report of preconstruction conference.
 12. Certificates of insurance and insurance policies.
 13. Performance and payment bonds.
 14. Data needed to acquire Owner's insurance.
- I. Subsequent Application for Payment: After issuing the Initial Application for Payment, administrative actions and submittals that must precede or coincide with submittal of remaining Applications for Payment include the following:

1. Reports and other documents indicated in Section 013200 "Construction Progress Documentation."
 2. Closeout Submittal List (preliminary, if not final).
- J. Retainage Reduction:
1. Owner shall pay the amount due to the Contractor on account of progress payments as indicated in the Agreement. After completion of a percentage of the Work, as agreed, the Contractor shall submit, for Owner's and Architect's review and approval a written request for retainage reduction. Upon Owner's approval, with written consent of the surety, the Architect may certify remaining partial payments to be paid in full.
 2. The Contractor, as a condition precedent to retainage reduction shall submit, for review and approval by the Architect, the required Operation and Maintenance Manuals.
- K. Application for Payment at Substantial Completion: After Architect issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
 - a. Complete administrative actions, submittals, and Work preceding this application, as described in Section 017700 "Closeout Procedures."
- L. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
1. Evidence of completion of Project closeout requirements.
 2. Certification of completion of final punch list items.
 3. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
 4. Updated final statement, accounting for final changes to the Contract Sum.
 5. AIA Document G706.
 6. AIA Document G706A.
 7. AIA Document G707.
 8. Evidence that claims have been settled.
 9. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
 10. Final liquidated damages settlement statement.
 11. Proof that taxes, fees, and similar obligations are paid.
 12. Waivers and releases.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012900

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project, including, but not limited to, the following:
 - 1. General coordination procedures.
 - 2. Coordination drawings.
 - 3. RFIs.
 - 4. Digital project management procedures.
 - 5. Web-based Project management software package.
 - 6. Project meetings.

1.2 DEFINITIONS

- A. BIM: Building Information Modeling.
- B. RFI: Request for Information. Request from Owner, Construction Manager, Architect, or Contractor seeking information required by or clarifications of the Contract Documents.

1.3 INFORMATIONAL SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
 - 1. Name, address, telephone number, and email address of entity performing subcontract or supplying products.
 - 2. Number and title of related Specification Section(s) covered by subcontract.
 - 3. Drawing number and detail references, as appropriate, covered by subcontract.
- B. Key Personnel Names: Prior to starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses, cellular telephone numbers, and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.
 - 1. Post copies of list in Project meeting room, in temporary field office, in web-based Project software directory, and in prominent location in built facility. Keep list current at all times.

1.4 GENERAL COORDINATION PROCEDURES

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results, where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.

3. Make adequate provisions to accommodate items scheduled for later installation.
- B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
 1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
 1. Preparation of Contractor's construction schedule.
 2. Preparation of the schedule of values.
 3. Installation and removal of temporary facilities and controls.
 4. Delivery and processing of submittals.
 5. Progress meetings.
 6. Preinstallation conferences.
 7. Project closeout activities.
 8. Startup and adjustment of systems.

1.5 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely indicated on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
 1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
 - a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
 - b. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - c. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
 - d. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
 - e. Indicate required installation sequences.
 - f. Indicate dimensions shown on Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
 2. Review: Architect will review coordination drawings to confirm that, in general, the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Contractor, who shall make suitable modifications and resubmit.
 3. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Section 013300 "Submittal Procedures."
- B. Coordination Drawing Organization: Organize coordination drawings as follows:

1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
 2. Plenum Space: Indicate subframing for support of ceiling, raised access floor, and wall systems, mechanical and electrical equipment, and related Work. Locate components within plenums to accommodate layout of light fixtures and other components indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
 3. Mechanical Rooms: Provide coordination drawings for mechanical rooms, showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
 4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
 5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
 6. Mechanical and Plumbing Work: Show the following:
 - a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
 - b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
 - c. Fire-rated enclosures around ductwork.
 7. Electrical Work: Show the following:
 - a. Runs of vertical and horizontal conduit 1-1/4 inches in diameter and larger.
 - b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations.
 - c. Panel board, switchboard, switchgear, transformer, busway, generator, and motor-control center locations.
 - d. Location of pull boxes and junction boxes, dimensioned from column center lines.
 8. Fire-Protection System: Show the following:
 - a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.
- C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
 2. File Submittal Format: Submit or post coordination drawing files using format same as file preparation format or PDF format.
 3. Architect will furnish Contractor one set of digital data files of Drawings for use in preparing coordination digital data files.
 - a. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Drawings.
 - b. Digital Data Software Program: Drawings are available in AutoCAD translated from Revit file.
 - c. Contractor shall execute a data licensing agreement in the form of Agreement included in this Project Manual.

1.6 REQUEST FOR INFORMATION (RFI)

- A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
1. Architect will return without response those RFIs submitted to Architect by other entities controlled by Contractor.

2. Coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
1. Project name.
 2. Owner name.
 3. Name of Architect and Construction Manager.
 4. Architect's Project number.
 5. Date.
 6. Name of Contractor.
 7. RFI number, numbered sequentially.
 8. RFI subject.
 9. Specification Section number and title and related paragraphs, as appropriate.
 10. Drawing number and detail references, as appropriate.
 11. Field dimensions and conditions, as appropriate.
 12. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 13. Contractor's signature.
 14. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. RFI Forms: Software-generated form via the Project Information Management System.
1. Attachments shall be electronic files in PDF format.
- D. Architect's and Construction Manager's Action: Architect and Construction Manager will review each RFI, determine action required, and respond. Allow five days for Architect's response for each RFI. RFIs received by Architect or Construction Manager after 1:00 p.m. will be considered as received the following working day.
1. The following Contractor-generated RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.
 - e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of Architect's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.
 2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt by Architect or Construction Manager of additional information.
 3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."
 - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect and Construction Manager in writing within 5 days of receipt of the RFI response.
- E. RFI Log: Use software log that is part of web-based Project management software.

- F. On receipt of Architect's and Construction Manager's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect and Construction Manager within seven days if Contractor disagrees with response.

1.7 DIGITAL PROJECT MANAGEMENT PROCEDURES

- A. Use of Architect's Digital Data Files: Electronic copies of digital data files of the Contract Drawings will be available from Architect for Contractor's use during construction.
1. Digital data files may be used by Contractor in preparing coordination drawings, Shop Drawings, and Project Record Drawings.
 2. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Contract Drawings.
 3. Digital Drawing Software Program: Contract Drawings are available in AutoCAD translated from Revit file.
 4. The digital data files are available under the following conditions:
 - a. Contractor shall execute a data licensing agreement in the form of Digital Data Letter of Agreement.
 - b. Digital data drawings are not to be considered Contract Documents as defined by the General Conditions for the Contract for Construction.
 - c. The Contract Documents executed or identified in the Owner/Contractor Agreement, shall prevail in case of an inconsistency with subsequent versions made through manipulatable electronic operations involving computers.
 - d. The Contractor shall not transfer or reuse Instruments of Service in electronic or machine-readable form without the prior written consent of the Architect.
- B. Web-Based Project Management Software Package: Use Architect's web-based Project management software package for purposes of hosting and managing Project communication and documentation until Final Completion.
1. Web-based Project management software includes, at a minimum, the following features:
 - a. Compilation of Project data, including Contractor, subcontractors, Architect, Architect's consultants, Owner, and other entities involved in Project. Include names of individuals and contact information.
 - b. Access control for each entity for each workflow process, to determine entity's digital rights to create, modify, view, and print documents.
 - c. Document workflow planning, allowing customization of workflow between project entities.
 - d. Creation, logging, tracking, and notification for Project communications required in other Specification Sections, including, but not limited to, RFIs, submittals, Minor Changes in the Work, Construction Change Directives, and Change Orders.
 - e. Track status of each Project communication in real time, and log time and date when responses are provided.
 - f. Procedures for handling PDFs or similar file formats, allowing markups by each entity. Provide security features to lock markups against changes once submitted.
 - g. Processing and tracking of payment applications.
 - h. Processing and tracking of contract modifications.
 - i. Creating and distributing meeting minutes.
 - j. Document management for Drawings, Specifications, and coordination drawings, including revision control.
 - k. Management of construction progress photographs.
 - l. Mobile device compatibility, including smartphones and tablets.
- C. PDF Document Preparation: Where PDFs are required to be submitted to Architect, prepare as follows:

1. Assemble complete submittal package into a single indexed file, incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
2. Name file with submittal number or other unique identifier, including revision identifier.
3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

1.8 PROJECT MEETINGS

A. General: Construction Manager will schedule and conduct meetings and conferences at Project site unless otherwise indicated.

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times a minimum of 10 days prior to meeting.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner, Construction Manager, and Architect, within three days of the meeting.

B. Preconstruction Conference: Architect will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner, Construction Manager and Architect.

1. Attendees: Authorized representatives of Owner, Construction Manager, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Responsibilities and personnel assignments.
 - b. Tentative construction schedule.
 - c. Phasing.
 - d. Critical work sequencing and long lead items.
 - e. Designation of key personnel and their duties.
 - f. Lines of communications.
 - g. Use of web-based Project software.
 - h. Procedures for processing field decisions and Change Orders.
 - i. Procedures for RFIs.
 - j. Procedures for testing and inspecting.
 - k. Procedures for processing Applications for Payment.
 - l. Distribution of the Contract Documents.
 - m. Submittal procedures.
 - n. Preparation of Record Documents.
 - o. Use of the premises.
 - p. Work restrictions.
 - q. Working hours.
 - r. Owner's occupancy requirements.
 - s. Responsibility for temporary facilities and controls.
 - t. Procedures for moisture and mold control.
 - u. Procedures for disruptions and shutdowns.
 - v. Construction waste management and recycling.
 - w. Parking availability.
 - x. Office, work, and storage areas.
 - y. Equipment deliveries and priorities.
 - z. First aid.
 - aa. Security.

- bb. Progress cleaning.
 - cc. Bonds and insurance.
 - 3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity when required by other Sections and when required for coordination with other construction.
- 1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect, Construction Manager of scheduled meeting dates.
 - 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. Contract Documents.
 - b. Options.
 - c. Related RFIs.
 - d. Related Change Orders.
 - e. Purchases.
 - f. Deliveries.
 - g. Submittals.
 - h. Review of mockups.
 - i. Possible conflicts.
 - j. Compatibility requirements.
 - k. Time schedules.
 - l. Weather limitations.
 - m. Manufacturer's written instructions.
 - n. Warranty requirements.
 - o. Compatibility of materials.
 - p. Acceptability of substrates.
 - q. Temporary facilities and controls.
 - r. Space and access limitations.
 - s. Regulations of authorities having jurisdiction.
 - t. Testing and inspecting requirements.
 - u. Installation procedures.
 - v. Coordination with other work.
 - w. Required performance results.
 - x. Protection of adjacent work.
 - y. Protection of construction and personnel.
 - 3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 - 4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
 - 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Project Closeout Conference: Construction Manager will schedule and conduct a project closeout conference, at a time convenient to Owner and Architect, but no later than 90 days prior to the scheduled date of Substantial Completion.
- 1. Conduct the conference to review requirements and responsibilities related to Project closeout.
 - 2. Attendees: Authorized representatives of Owner, Construction Manager, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.

3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
 - a. Preparation of Record Documents.
 - b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
 - c. Procedures for completing and archiving web-based Project software site data files.
 - d. Submittal of written warranties.
 - e. Requirements for preparing operations and maintenance data.
 - f. Requirements for delivery of material samples, attic stock, and spare parts.
 - g. Requirements for demonstration and training.
 - h. Preparation of Contractor's punch list.
 - i. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
 - j. Submittal procedures.
 - k. Owner's partial occupancy requirements.
 - l. Installation of Owner's furniture, fixtures, and equipment.
 - m. Responsibility for removing temporary facilities and controls.
 4. Minutes: Entity conducting meeting will record and distribute meeting minutes.
- E. Progress Meetings: Construction Manager will conduct progress meetings at monthly intervals.
1. Attendees: In addition to representatives of Owner, Construction Manager, and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Coordinate dates of meetings with preparation of payment requests.
 3. Status Report: Contractor shall provide written report outlining the following:
 - a. Work done in last 30 days.
 - b. Work scheduled for next 30 days.
 - c. RFI status.
 - d. Submittal status.
 - e. Allowance recap.
 - f. Pre-Installation meetings scheduled.
 - g. Narrative of progress schedule status.
 4. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - 1) Review schedule for next period.
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Status of submittals.
 - 4) Deliveries.
 - 5) Off-site fabrication.
 - 6) Access.

-
- 7) Site use.
 - 8) Temporary facilities and controls.
 - 9) Progress cleaning.
 - 10) Quality and work standards.
 - 11) Status of correction of deficient items.
 - 12) Field observations.
 - 13) Status of RFIs.
 - 14) Status of Proposal Requests.
 - 15) Pending changes.
 - 16) Status of Change Orders.
 - 17) Pending claims and disputes.
 - 18) Documentation of information for payment requests.
5. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
 - a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting, where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.
- F. Coordination Meetings: Construction Manager will conduct Project coordination meetings at weekly intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.
1. Attendees: In addition to representatives of Owner , Construction Manager, and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting, where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
 - c. Review present and future needs of each contractor present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Status of submittals.
 - 4) Deliveries.
 - 5) Off-site fabrication.
 - 6) Access.
 - 7) Site use.
 - 8) Temporary facilities and controls.
 - 9) Work hours.
 - 10) Hazards and risks.
 - 11) Progress cleaning.
 - 12) Quality and work standards.
 - 13) Status of RFIs.
 - 14) Proposal Requests.

- 15) Change Orders.
 - 16) Pending changes.
- 3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
1. Startup construction schedule.
 2. Contractor's Construction Schedule.
 3. Construction schedule updating reports.
 4. Daily construction reports.
 5. Site condition reports.
 6. Unusual event reports.

1.2 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction Project. Activities included in a construction schedule consume time and resources.
1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
 2. Predecessor Activity: An activity that precedes another activity in the network.
 3. Successor Activity: An activity that follows another activity in the network.
- B. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine the critical path of Project and when activities can be performed.
- C. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- D. Event: The starting or ending point of an activity.
- E. Float: The measure of leeway in starting and completing an activity.
1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
- F. Resource Loading: The allocation of manpower and equipment necessary for completing an activity as scheduled.

1.3 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:
1. Working electronic copy of schedule file.
 2. PDF file.

- B. Startup construction schedule.
- C. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
 - 1. Submit a working digital copy of schedule, using software indicated, and labeled to comply with requirements for submittals.
- D. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
 - 1. Activity Report: List of activities sorted by activity number and then early start date, or actual start date if known.
 - 2. Logic Report: List of preceding and succeeding activities for each activity, sorted in ascending order by activity number and then by early start date, or actual start date if known.
 - 3. Total Float Report: List of activities sorted in ascending order of total float.
- E. Construction Schedule Updating Reports: Submit with Applications for Payment.
- F. Daily Construction Reports: Submit at monthly intervals.
- G. Site Condition Reports: Submit at time of discovery of differing conditions.
- H. Unusual Event Reports: Submit at time of unusual event.

1.4 COORDINATION

- A. Coordinate Contractor's Construction Schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests, and other required schedules and reports.
 - 1. Secure time commitments for performing critical elements of the Work from entities involved.
 - 2. Coordinate each construction activity in the network with other activities, and schedule them in proper sequence.

1.5 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.
- B. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Final Completion.
 - 1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
 - 2. The Contractor shall conduct his operations so the completion date in the Agreement is met.
- C. Activities: Treat each floor or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
 - 1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
 - 2. Temporary Facilities: Indicate start and completion dates for the following as applicable:
 - a. Securing of approvals and permits required for performance of the Work.
 - b. Temporary facilities.

- c. Construction of mock-ups, prototypes and samples.
 - d. Owner interfaces and furnishing of items.
 - e. Interfaces with Separate Contracts.
 - f. Regulatory agency approvals.
 - g. Punch list.
 3. Procurement Activities: Include procurement process activities for the following long lead-time items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 4. Submittal Review Time: Include review and resubmittal times indicated in Section 013300 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with submittal schedule.
 5. Concrete Slabs: Schedule, coordinate, and install concrete slabs in a timely manner to allow concrete to cure sufficiently for moisture-sensitive floor finishes. Failure to do so, resulting in the requirement for moisture mitigation, will be Contractor's responsibility.
 6. Startup and Testing Time: Include no fewer than 14 days for startup and testing.
 7. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's and Construction Manager's administrative procedures necessary for certification of Substantial Completion.
 8. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and Final Completion.
- D. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
1. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
 2. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
 - a. Subcontract awards.
 - b. Submittals.
 - c. Purchases.
 - d. Mockups.
 - e. Fabrication.
 - f. Sample testing.
 - g. Deliveries.
 - h. Installation.
 - i. Tests and inspections.
 - j. Adjusting.
 - k. Curing.
 - l. Startup and placement into final use and operation.
 3. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
 - a. Structural completion.
 - b. Temporary enclosure and space conditioning.
 - c. Permanent space enclosure.
 - d. Completion of mechanical installation.
 - e. Completion of electrical installation.
 - f. Substantial Completion.
- E. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Completion.

- F. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
1. Unresolved issues.
 2. Unanswered Requests for Information.
 3. Rejected or unreturned submittals.
 4. Notations on returned submittals.
 5. Pending modifications affecting the Work and the Contract Time.
- G. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
1. Original target dates shall be retained in scheduling software for the duration of the Project.
 2. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
 3. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
 4. As the Work progresses, indicate Final Completion percentage for each activity.
- H. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, equipment required to achieve compliance, and date by which recovery will be accomplished.
- I. Distribution: Distribute copies of approved schedule to Architect, Construction Manager, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
1. Post copies in Project meeting rooms and temporary field offices.
 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

1.6 STARTUP CONSTRUCTION SCHEDULE

- A. Bar Chart Schedule: Submit startup, horizontal, Gantt-chart-type construction schedule within seven days of date established for the Notice to Proceed.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 90 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

1.7 CPM SCHEDULE REQUIREMENTS

- A. Prepare network diagrams using AON (activity-on-node) format.
- B. CPM Schedule: Prepare Contractor's Construction Schedule using a time-scaled CPM network analysis diagram for the Work.
1. Develop network diagram in sufficient time to submit CPM schedule, so it can be accepted for use no later than 45 days after date established for the Notice to Proceed.
 - a. Failure to include any work item required for performance of this Contract shall not excuse Contractor from completing all work within applicable completion dates.

2. Conduct educational workshops to train and inform key Project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.
 3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
 4. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule to coordinate with the Contract Time.
- C. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the startup network diagram, prepare a skeleton network to identify probable critical paths.
1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
 - a. Preparation and processing of submittals.
 - b. Mobilization and demobilization.
 - c. Purchase of materials.
 - d. Delivery.
 - e. Fabrication.
 - f. Utility interruptions.
 - g. Installation.
 - h. Work by Owner that may affect or be affected by Contractor's activities.
 - i. Testing and inspection.
 - j. Punch list and Final Completion.
 2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
 3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
 4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.
 - a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.
- D. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall Project schedule.
- E. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start-total float." Identify critical activities. Prepare tabulated reports showing the following:
1. Contractor or subcontractor and the Work or activity.
 2. Description of activity.
 3. Main events of activity.
 4. Immediate preceding and succeeding activities.
 5. Early and late start dates.
 6. Early and late finish dates.
 7. Activity duration in workdays.
 8. Total float or slack time.
 9. Average size of workforce.
- F. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:
1. Identification of activities that have changed.
 2. Changes in early and late start dates.
 3. Changes in early and late finish dates.

4. Changes in activity durations in workdays.
5. Changes in the critical path.
6. Changes in total float or slack time.
7. Changes in the Contract Time.

G. Causes for Extensions of Time:

1. The Contract completion date will be adjusted only for causes specified in the Contract. In the event the Contractor requests an extension of the Contract completion date, the Contractor shall furnish justification and supporting evidence as required by this Section and the General Conditions. The Owner will, after receipt of such justification and supporting evidence, make findings of fact and advise the Contractor in writing thereof. If the Owner determines that the Contractor is entitled to an extension of the Contract completion date, the Owner's determination of the time extension owed shall be based upon the approved CPM schedule or update. Actual delays in activities, which do not affect the scheduled Contract completion date, shall not serve as the basis for a change in Contract completion time.
2. The procedure for preparing and presenting delay justification is as follows:
 - a. Create a schedule activity (or activities) that represent the scope of the change or delay.
 - b. Assign durations and cost/manpower resources to these new activities.
 - c. Determine appropriate logic ties for these new activities. Assign predecessors and successors so that these activities can tie into the existing schedule activities.
 - d. These impact activities should be loaded into a separate copy of the updated schedule that immediately precedes the impact issue's time frame. For instance, if an impact issue occurs during mid-April, the new activities should be input into the March 31 (status date) update.
 - e. Recalculate the Schedule with these impact activities in place.
3. The Impacted Schedule, along with the backup data describing the new schedule activities and logic ties which comprise the impact/delay issues, will be submitted to the Owner for review and approval. If approved, these impact/delay issues will become a permanent part of the Project Schedule. The Contractor shall not unilaterally make changes to the Project Schedule to justify schedule impacts without the approval of the Owner.
4. Activity delays shall not automatically mean that an extension of the Contract Time is warranted or due the Contractor. Only those delays which impact the imposed Contract Completion Date or other CPM and contract milestone dates will be considered for time extensions.
5. Failure of the Contractor to furnish justification and supporting evidence for an extension of time, as detailed in this Section, within thirty (30) calendar days of the changed condition shall constitute a waiver of any claims for time extension associated with the issue.

1.8 REPORTS

- A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
1. List of subcontractors at Project site.
 2. List of separate contractors at Project site.
 3. Approximate count of personnel at Project site.
 4. Equipment at Project site.
 5. Material deliveries.
 6. High and low temperatures and general weather conditions, including presence of rain or snow.
 7. Testing and inspection.
 8. Accidents.
 9. Meetings and significant decisions.
 10. Unusual events.
 11. Stoppages, delays, shortages, and losses.
 12. Meter readings and similar recordings.
 13. Emergency procedures.

14. Orders and requests of authorities having jurisdiction.
 15. Change Orders received and implemented.
 16. Construction Change Directives received and implemented.
 17. Services connected and disconnected.
 18. Equipment or system tests and startups.
 19. Partial completions and occupancies.
 20. Substantial Completions authorized.
- B. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.
- C. Unusual Event Reports: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, responses by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.
1. Submit unusual event reports directly to Owner within one day(s) of an occurrence. Distribute copies of report to parties affected by the occurrence.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013200

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Submittal schedule requirements.
2. Administrative and procedural requirements for submittals.

1.2 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Architect's and Construction Manager's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."
- B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's and Construction Manager's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

1.3 SUBMITTAL SCHEDULE

- A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and Construction Manager and additional time for handling and reviewing submittals required by those corrections.
 1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
 2. Initial Submittal Schedule: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
 3. Final Submittal Schedule: Submit concurrently with the first complete submittal of Contractor's construction schedule.
 - a. Submit revised submittal schedule as required to reflect changes in current status and timing for submittals.
 4. Format: Arrange the following information in a tabular format:
 - a. Scheduled date for first submittal.
 - b. Specification Section number and title.
 - c. Submittal Category: Action; informational.
 - d. Name of subcontractor.
 - e. Description of the Work covered.
 - f. Scheduled date for Architect's and Construction Manager's final release or approval.
 - g. Scheduled dates for purchasing.
 - h. Scheduled date of fabrication.
 - i. Scheduled dates for installation.
 - j. Activity or event number.

1.4 SUBMITTAL FORMATS

- A. Submittal Information: Include the following information in each submittal:
1. Project name.
 2. Date.
 3. Name of Architect.
 4. Name of Construction Manager.
 5. Name of Contractor.
 6. Name of firm or entity that prepared submittal.
 7. Names of subcontractor, manufacturer, and supplier.
 8. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier and alphanumeric suffix for resubmittals.
 9. Category and type of submittal.
 10. Submittal purpose and description.
 11. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
 12. Drawing number and detail references, as appropriate.
 13. Indication of full or partial submittal.
 14. Location(s) where product is to be installed, as appropriate.
 15. Other necessary identification.
 16. Remarks.
 17. Signature of transmitter.
- B. Options: Identify options requiring selection by Architect.
- C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Architect and Construction Manager on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.
- D. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:
1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
 2. Name file with submittal number or other unique identifier, including revision identifier.
 - a. File name shall be Specification Section number followed by a hyphen and then a sequential number (e.g. 081113 - 01 HM Doors and Frames). Resubmittals shall include a digital suffix after another hyphen (e.g. 081113 - 01 - 01 HM Doors and Frames).
 3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Architect.
 4. Transmittal Form for Electronic Submittals: Use software-generated form from electronic project information management system.
 5. Metadata: Include the following information as keywords in the electronic file metadata:
 - a. Project name.
 - b. Number and title of appropriate Specification Section.
 - c. Manufacturer name.
 - d. Product name.
- E. Submittals Utilizing Web-Based Project Software: Prepare submittals as PDF files or other format indicated by Project management software.

1.5 SUBMITTAL PROCEDURES

- A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
 - 1. Web-Based Project Management Software: Prepare submittals in PDF form, and upload to web-based Project management software website. Enter required data in web-based software site to fully identify submittal.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
 - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 - 2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
 - 3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
 - 4. Coordinate transmittal of submittals for related parts of the Work specified in different Sections, so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Architect and Construction Manager reserve the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Construction Manager's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
 - 1. Critical Review: Allow 15 days for review of each critical submittal.
 - a. Identify critical, long lead item submittals and submittals that require expedited (shorter) turn-around times within the submittal schedule.
 - 2. Initial Review: Allow 30 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Construction Manager will advise Contractor when a submittal being processed must be delayed for coordination.
 - 3. Resubmittal Review: Allow 15 days for review of each resubmittal.
 - 4. Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted simultaneously to Architect and to Architect's consultants, allow 30 days for review of each submittal. Submittal will be returned to Construction Manager, through Architect, before being returned to Contractor.
 - 5. Deferred Review: For non-critical submittals, including products that are not required until later in the Project, the Architect reserves the right to defer review to within 45 days.
- D. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
 - 1. Note date and content of previous submittal.
 - 2. Note date and content of revision in label or title block, and clearly indicate extent of revision.
 - 3. Resubmit submittals until they are marked with approval notation from Architect's and Construction Manager's action stamp.
- E. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

- F. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's and Construction Manager's action stamp.

1.6 SUBMITTAL REQUIREMENTS

- A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each submittal to show which products and options are applicable.
 3. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams that show factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 5. Submit Product Data before Shop Drawings, and before or concurrently with Samples.
- B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data unless submittal based on Architect's digital data drawing files is otherwise permitted.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.
 - g. Seal and signature of professional engineer if specified.
 2. Paper Sheet Size: Except for templates, patterns, and similar full-size Drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.
- C. Samples: Submit Samples for review of type, color, pattern, and texture for a check of these characteristics with other materials.
1. Transmit Samples that contain multiple, related components, such as accessories together in one submittal package.
 2. Identification: Permanently attach label on unexposed side of Samples that includes the following:
 - a. Project name and submittal number.

- b. Generic description of Sample.
 - c. Product name and name of manufacturer.
 - d. Sample source.
 - e. Number and title of applicable Specification Section.
 - f. Specification paragraph number and generic name of each item.
 3. Web-Based Project Management Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
 4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
 - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
 5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units, showing the full range of colors, textures, and patterns available.
 - a. Number of Samples: Submit one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect, through Construction Manager, will return submittal with options selected.
 6. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
 - a. Number of Samples: Submit three sets of Samples.
 - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
 - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
- D. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
 1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
 2. Manufacturer and product name, and model number if applicable.
 3. Number and name of room or space.
 4. Location within room or space.
- E. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.
- F. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and

summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.

G. Certificates:

1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
2. Installer Certificates: Submit written statements on manufacturer's letterhead, certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead, certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
4. Material Certificates: Submit written statements on manufacturer's letterhead, certifying that material complies with requirements in the Contract Documents.
5. Product Certificates: Submit written statements on manufacturer's letterhead, certifying that product complies with requirements in the Contract Documents.
6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of AWS B2.1/B2.1M on AWS forms. Include names of firms and personnel certified.

H. Test and Research Reports:

1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for substrate preparation and primers required.
2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
 - a. Name of evaluation organization.
 - b. Date of evaluation.
 - c. Time period when report is in effect.
 - d. Product and manufacturers' names.
 - e. Description of product.
 - f. Test procedures and results.
 - g. Limitations of use.

1.7 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF file paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
 - 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

1.8 CONTRACTOR'S REVIEW

- A. Action Submittals and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect and Construction Manager.
- B. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp. Include name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
 - 1. Architect and Construction Manager will not review submittals received from Contractor that do not have Contractor's review and approval.

1.9 ARCHITECT'S AND CONSTRUCTION MANAGER'S REVIEW

- A. Action Submittals: Architect and Construction Manager will review each submittal, annotate to indicate corrections or revisions required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.
 - 1. No Exceptions Taken: The work covered by the submittal may proceed.
 - 2. Note Markings: The work covered by the submittal may proceed provided it complies with both the Architect's notations and corrections on the submittal and the Contract Documents.
 - 3. Rejected: Do not proceed with the Work covered by the submittal. Prepare a new submittal for a product that complies with the contract document.
- B. Informational Submittals: Architect and Construction Manager will review each submittal and will return it, noting "No Action Taken." If it does not comply with requirements, Architect will return it noting "Revise and Resubmit." Architect and Construction Manager will forward each submittal to appropriate party.
- C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect and Construction Manager.
- D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review, with notation "Revise and Resubmit."
- E. Submittals not required by the Contract Documents may be returned by the Architect without action, with notation "No Action Taken."

- F. Architect and Construction Manager will return without review submittals received from sources other than Contractor.
- G. Submittals not required by the Contract Documents will be returned by Architect without action.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013300

DIGITAL DATA LETTER OF AGREEMENT

An Agreement Between the Architect and _____ (the "Transferee,"
either Original or Third Party, as the case may be) for Transfer of Digital Data

Architect:	LS3P	Transferee:
	101 N. Third Street, Suite 500	Original
	Wilmington, North Carolina 28401	3 rd Party
	Contact: Laura Miller, AIA	

Contract No.:

Project No.: 7702-190810

Project Name: New Hanover County Government Center

Location: Wilmington, NC

Date:

The Architect will provide the following Digital Data, dated as of the particular transmission, to the Transferee
for information purposes only:

Digital Data was prepared using the following:

Software:	AutoCAD (.dwg)	Version:
	MicroStation (.dgn)	
	Revit (.rvt)	

Digital Data to be delivered via the following media: Newforma Website posting

Transferee shall pay the Architect a service fee of \$_____ and other good and valuable consideration.

TERMS AND CONDITIONS

1. The Architect and its consultants make no representation as to the compatibility of the Digital Data with any hardware or software. The Transferee shall notify the Architect within five (5) business days of any problems associated with accessing and/or using the Digital Data.
2. The Transferee acknowledges and agrees that the Digital Data can be modified unintentionally or otherwise. The Transferee acknowledges and agrees that the Architect and its consultants may remove all indications of ownership from the Digital Data prior to transmission.
3. All Digital Data shall be considered the property of the Architect and/or its consultants and shall not be used for other Projects, for additions to this Project, or for completion of this Project without the prior written permission of the Architect and/or its consultants. Digital Data shall not be re-transmitted by the Original Transferee to a Third Party Transferee without prior execution of an agreement identical to this Agreement between the Architect, the Original Transferee, and the Third Party Transferee. Under no circumstances shall the transmission of the Digital Data be considered a sale of goods or a sale of copyrights.

4. THE ARCHITECT AND THE ARCHITECT'S CONSULTANTS HEREBY EXPRESSLY DISCLAIM ANY AND ALL WARRANTIES, BOTH EXPRESS AND IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTY OF MERCHANTABILITY AND THE IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE AS WELL AS ANY WARRANTY OF ACCURACY, COMPLETENESS, AND/OR PERMANENCE. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTION ON THE FACE HEREOF. Addenda information and/or revisions made to the most current Digital Data after any date of transmission may not have been incorporated into the transmitted Digital Data. The Architect may update the Digital Data and give notice to authorized parties (or not) as is consistent with the Architect's professional skill and care and the orderly progress of the Work. In the event of a conflict between the Architect's printed instruments of service (whether sealed or not) and the Digital Data, the printed instruments of service shall govern. The Transferee acknowledges and agrees that the duty to determine the existence of any and all conflicts between the Digital Data and any other information upon which the Transferee relies rests solely upon the Transferee. The Digital Data shall not be considered Contract Documents or Construction Documents as defined by any General Conditions of Contract for Construction. The Digital Data is being provided on a strictly "AS IS" basis.

5. The use and/or provision of the Digital Data prepared by the Architect and/or its consultants shall not in any way reduce or obviate the Transferee's duty to check and coordinate dimensions, details, and quantities of materials as required to facilitate construction of the Project. Confirmation of existing conditions is the sole responsibility of the Transferee.

6. The Transferee agrees to the extent permitted by applicable law, to indemnify, hold harmless, release, and defend the Architect and/or its consultants, their officers, shareholders, employees, and sub-consultants from any and all injuries, claims, demands, expenses, suits, liabilities, losses, damages, costs, disputes, other matters in question, third party claims, pass-through claims, subrogated claims, and/or claim expenses related to the Digital Data, including but not limited to, attorneys' fees, expert witness fees, and court costs arising out of or in any way related to or connected with any negligent act and/or omission in the generation, provision, and/or use of the Digital Data by the Transferee and/or any of its subcontractors, suppliers, and/or consultants and waive any and all rights to such claims and causes of action.

7. The Transferee waives damages against the Architect for any and all injuries, claims, losses, expenses, damages, disputes, other matters in question, and/or claim expenses arising out of or relating to this Agreement and/or generation, provision, and/or use of the Digital Data, including, but not limited to, consequential damages and reasonable attorneys' fees and defense costs.

8. The Architect's and/or the Architect's consultants' liability to the Transferee and/or any of its subcontractors, suppliers, and/or consultants for any and all injuries, claims, losses, expenses, damages, disputes, other matters in question, third party claims, pass-through claims, subrogated claims, and/or claim expenses arising out of or relating to this Agreement and/or the Digital Data, including, but not limited to, reasonable attorneys' fees and defense costs, regardless of the nature of the claim or damage, shall not exceed, either individually or in the aggregate, the total amount of \$1,000.00. Such causes include, but are not limited to, the Architect's and/or the Architect's consultants' negligence, errors, omissions, strict liability, breach of contract, and/or breach of warranty.

9. Upon information and belief, there are no licensing or copyright fees due to others based on the transmission of the Digital Data, but to the extent that such unknown fees do exist, the Transferee agrees to pay the required fees and hold the Architect and/or its consultants harmless from any associated costs or penalties.

10. Upon execution of this Agreement, the Architect grants to the Transferee a non-exclusive, non-transferable (except as set forth herein) license to use the Digital Data solely and exclusively for informational purposes



only, provided that the Transferee substantially performs its obligations, including prompt payment of all sums when due, under this Agreement.

11. Any purchase order number provided by the Transferee is for the Transferee's accounting purposes only. The Transferee acknowledges and agrees that purchase order terms and conditions are null, void, and inapplicable to this Agreement.

12. Payment of the service fee set forth herein is due prior to transmission of the Digital Data.

13. This Agreement constitutes the entire agreement between the parties relative to the Digital Data and shall be governed by the laws of the State of North Carolina.

AUTHORIZED ACCEPTANCE

by Architect:
LS3P

Signature

Print Name and Title

Date

by Original Transferee:

Signature

Print Name and Title

Date

by Third Party Transferee:

Signature

Print Name and Title

Date

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
 - 3. Requirements for Contractor to provide quality-assurance and quality-control services required by Architect, Owner, Construction Manager, or authorities having jurisdiction are not limited by provisions of this Section.

1.2 DEFINITIONS

- A. Experienced: When used with an entity or individual, "experienced," unless otherwise further described, means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- B. Field Quality-Control Tests and Inspections: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, subcontractor, or sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.
 - 1. Use of trade-specific terminology in referring to a Work result does not require that certain construction activities specified apply exclusively to specific trade(s).
- D. Mockups: Physical assemblies of portions of the Work constructed to establish the standard by which the Work will be judged. Mockups are not Samples.
 - 1. Mockups are used for one or more of the following:
 - a. Verify selections made under Sample submittals.
 - b. Demonstrate aesthetic effects.
 - c. Demonstrate the qualities of products and workmanship.
 - d. Demonstrate successful installation of interfaces between components and systems.
 - e. Perform preconstruction testing to determine system performance.
 - 2. Product Mockups: Mockups that may include multiple products, materials, or systems specified in a single Section.
 - 3. In-Place Mockups: Mockups constructed on-site in their actual final location as part of permanent construction.

- E. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria. Unless otherwise indicated, copies of reports of tests or inspections performed for other than the Project do not meet this definition.
- F. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- G. Source Quality-Control Tests and Inspections: Tests and inspections that are performed at the source (e.g., plant, mill, factory, or shop).
- H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. The term "testing laboratory" has the same meaning as the term "testing agency."
- I. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work, to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- J. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work, to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Architect or Construction Manager.

1.3 DELEGATED DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated Design Services Statement: Submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.4 CONFLICTING REQUIREMENTS

- A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements is specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, inform the Architect regarding the conflict and obtain clarification prior to proceeding with the Work. Refer conflicting requirements that are different, but apparently equal, to Architect for clarification before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified is the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.5 INFORMATIONAL SUBMITTALS

- A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
- B. Qualification Data: For Contractor's quality-control personnel.
- C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:
 - 1. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.
 - 2. Primary wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.
- D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
 - 1. Specification Section number and title.
 - 2. Entity responsible for performing tests and inspections.
 - 3. Description of test and inspection.
 - 4. Identification of applicable standards.
 - 5. Identification of test and inspection methods.
 - 6. Number of tests and inspections required.
 - 7. Time schedule or time span for tests and inspections.
 - 8. Requirements for obtaining samples.
 - 9. Unique characteristics of each quality-control service.
- F. Reports: Prepare and submit certified written reports and documents as specified.
- G. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

1.6 CONTRACTOR'S QUALITY-CONTROL PLAN

- A. Quality-Control Plan, General: Submit quality-control plan within 10 days of Notice of Award, and not less than five days prior to preconstruction conference. Submit in format acceptable to Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities and to coordinate Owner's quality-assurance and quality-control activities. Coordinate with Contractor's Construction Schedule.
- B. Quality-Control Personnel Qualifications: Engage qualified personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.
 - 1. Project quality-control manager may also serve as Project superintendent.
- C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.

- D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:
1. Contractor-performed tests and inspections, including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections. Distinguish source quality-control tests and inspections from field quality-control tests and inspections.
 2. Special inspections required by authorities having jurisdiction and indicated on the Statement of Special Inspections.
 3. Owner-performed tests and inspections indicated in the Contract Documents.
- E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring the Work into compliance with standards of workmanship established by Contract requirements and approved mockups.
- F. Monitoring and Documentation: Maintain testing and inspection reports, including log of approved and rejected results. Include Work Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming Work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.7 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
1. Date of issue.
 2. Project title and number.
 3. Name, address, telephone number, and email address of testing agency.
 4. Dates and locations of samples and tests or inspections.
 5. Names of individuals making tests and inspections.
 6. Description of the Work and test and inspection method.
 7. Identification of product and Specification Section.
 8. Complete test or inspection data.
 9. Test and inspection results and an interpretation of test results.
 10. Record of temperature and weather conditions at time of sample-taking and testing and inspection.
 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 12. Name and signature of laboratory inspector.
 13. Recommendations on retesting and reinspecting.
- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, telephone number, and email address of technical representative making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Statement that products at Project site comply with requirements.
 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 6. Statement of whether conditions, products, and installation will affect warranty.
 7. Other required items indicated in individual Specification Sections.

- C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, telephone number, and email address of factory-authorized service representative making report.
 2. Statement that equipment complies with requirements.
 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 4. Statement of whether conditions, products, and installation will affect warranty.
 5. Other required items indicated in individual Specification Sections.

1.8 QUALITY ASSURANCE

- A. Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that is similar in material, design, and extent to those indicated for this Project.
- F. Specialists: Certain Specification Sections require that specific construction activities be performed by entities who are recognized experts in those operations. Specialists will satisfy qualification requirements indicated and engage in the activities indicated.
1. Requirements of authorities having jurisdiction supersede requirements for specialists.
- G. Testing and Inspecting Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented in accordance with ASTM E329, and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
- H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect, demonstrate, repair, and perform service on installations of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

- J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following Contractor's responsibilities, including the following:
1. Provide test specimens representative of proposed products and construction.
 2. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
 3. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
 4. Build site-assembled test assemblies and mockups, using installers who will perform same tasks for Project.
 5. When testing is complete, remove test specimens and test assemblies, and mockups; do not reuse products on Project.
 6. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect, through Construction Manager, with copy to Contractor. Interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from the Contract Documents.
- K. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
1. Build mockups in location indicated or, if not indicated, as directed by Architect or Construction Manager.
 2. Notify Architect and Construction Manager seven days in advance of dates and times when mockups will be constructed.
 3. Employ supervisory personnel who will oversee mockup construction. Employ workers who will be employed to perform same tasks during the construction at Project.
 4. Demonstrate the proposed range of aesthetic effects and workmanship.
 5. Obtain Architect's and Construction Manager's approval of mockups before starting corresponding Work, fabrication, or construction.
 - a. Allow seven days for initial review and each re-review of each mockup.
 6. Promptly correct unsatisfactory conditions noted by Architect's preliminary review, to the satisfaction of the Architect, before completion of final mockup.
 7. Approval of mockups by the Architect does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 8. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 9. Demolish and remove mockups when directed unless otherwise indicated.
- L. Specialty Mockups: See Section 014339 "Mockups" for additional construction requirements for integrated exterior mockups and room mockups.

1.9 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
 2. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor.

- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.
1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
 2. Engage a qualified testing agency to perform quality-control services.
 - a. Contractor will not employ same entity engaged by Owner, unless agreed to in writing by Owner.
 3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspection will be performed.
 4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 5. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- D. Testing Agency Responsibilities: Cooperate with Architect, Construction Manager, and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect, Construction Manager, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
 3. Conduct and interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from requirements.
 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 6. Do not perform duties of Contractor.
- E. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."
- F. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- G. Contractor's Associated Requirements and Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
1. Access to the Work.
 2. Incidental labor and facilities necessary to facilitate tests and inspections.

3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
 4. Facilities for storage and field curing of test samples.
 5. Delivery of samples to testing agencies.
 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 7. Security and protection for samples and for testing and inspection equipment at Project site.
- H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.

1.10 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: Owner will engage a qualified special inspector to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner, and as follows:
1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures, and reviewing the completeness and adequacy of those procedures to perform the Work.
 2. Notifying Architect, Construction Manager, and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
 3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect, through Construction Manager, with copy to Contractor and to authorities having jurisdiction.
 4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
 5. Interpreting tests and inspections, and stating in each report whether tested and inspected Work complies with or deviates from the Contract Documents.
 6. Retesting and reinspecting corrected Work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
1. Date test or inspection was conducted.
 2. Description of the Work tested or inspected.
 3. Date test or inspection results were transmitted to Architect.
 4. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's and Construction Manager's and authorities' having jurisdiction reference during normal working hours.
1. Submit log at Project closeout as part of Project Record Documents.

3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspection, sample-taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

SECTION 014200 - REFERENCES

PART 1 - GENERAL

1.1 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.
- H. "Provide": Furnish and install, complete and ready for the intended use.
- I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.2 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
 - 1. For standards referenced by applicable building codes, comply with dates of standards as listed in building codes.
- C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
 - 1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.3 ABBREVIATIONS AND ACRONYMS

- A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."
- B. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is believed to be accurate as of the date of the Contract Documents.
 - 1. ICC - International Code Council; www.iccsafe.org.
 - 2. ICC-ES - ICC Evaluation Service, LLC; www.icc-es.org.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 014200

SECTION 014339 - MOCKUPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Room mockups.

B. Related Requirements:

1. Section 014000 "Quality Requirements" for quality assurance requirements for aesthetic and workmanship mockups specified in other Sections.

1.2 DEFINITIONS

- A. Room Mockups: Mockups of typical interior spaces complete with wall, floor, and ceiling finishes; doors; windows; millwork; casework; specialties; furnishings and equipment; and lighting as indicated.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Construction Manager, Architect, testing and inspecting agency representative, and installers of major systems whose Work is included in integrated exterior and room mockups.
2. Review coordination of equipment and furnishings provided by the Owner for room mockups.
3. Review locations and extent of mockups.
4. Review testing procedures to be performed on mockups.
5. Review and finalize schedule for mockups, and verify availability of materials, personnel, equipment, and facilities needed to complete mockups and maintain schedule for the Work.

1.4 QUALITY ASSURANCE

A. Build mockups to do the following:

1. Verify selections made under Sample submittals.
2. Demonstrate aesthetic effects.
3. Demonstrate the qualities of products and workmanship.
4. Demonstrate acceptable coordination between components and systems.

B. Fabrication: Before fabricating or installing portions of the Work requiring mockups, build mockups for each form of construction and finish required. Use materials and installation methods as required for the Work.

1. Build mockups in location indicated or, if not indicated, as directed by Architect or Construction Manager.
2. Employ supervisory personnel who will oversee mockup construction. Employ workers who will be employed to perform same tasks during the construction at Project.
3. Demonstrate the proposed range of aesthetic effects and workmanship.
4. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
5. Demolish and remove mockups when directed unless otherwise indicated.

C. Notifications:

1. Notify Architect and Construction Manager seven days in advance of the dates and times when mockups will be constructed.
 2. Allow seven days for initial review and each re-review of each mockup.
- D. Approval: Obtain Architect's and Construction Manager's approval of mockups before starting fabrication or construction of corresponding Work.
1. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 COORDINATION

- A. Coordinate schedule for construction of mockups, so construction, testing, and review of mockups do not impact Project schedule.

PART 2 - PRODUCTS

2.1 ROOM MOCKUPS

- A. Build room mockups to evaluate constructability, demonstrate the coordination of trades and sequencing of Work, and to demonstrate aesthetic requirements. Include each visible finish, component, and equipment item within room mockups; include operable lighting.
- B. Provide room mockups as instructed by Architect.
- C. The Work of room mockups includes, but is not limited to, the following:
1. Millwork and casework.
 2. Doors and frames.
 3. Access doors and frames.
 4. Glazing.
 5. Metal framing.
 6. Gypsum board.
 7. Ceramic tiling.
 8. Acoustical ceilings.
 9. Resilient flooring.
 10. Painting.
 11. Registers and grilles.
 12. Wiring devices.
 13. Lighting.

PART 3 - EXECUTION (Not Used)

END OF SECTION 014339

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

1.2 USE CHARGES

- A. Sewer Service: Pay sewer-service use charges for sewer usage by all entities for construction operations.
- B. Water Service: Pay water-service use charges for water used by all entities for construction operations.
- C. Electric Power Service: Pay electric-power-service use charges for electricity used by all entities for construction operations.

1.3 INFORMATIONAL SUBMITTALS

- A. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.
- B. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.
- C. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.
- D. Moisture- and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold. Describe delivery, handling, storage, installation, and protection provisions for materials subject to water absorption or water damage.
 - 1. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and requirements for replacing water-damaged Work.
 - 2. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
 - 3. Indicate methods to be used to avoid trapping water in finished work.
- E. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Include the following:
 - 1. Locations of dust-control partitions at each phase of work.
 - 2. HVAC system isolation schematic drawing.
 - 3. Location of proposed air-filtration system discharge.
 - 4. Waste-handling procedures.
 - 5. Other dust-control measures.
- F. Noise and Vibration Control Plan: Identify construction activities that may impact the occupancy and use of existing spaces within the building or adjacent existing buildings, whether occupied by others, or occupied by the Owner. Include the following:

1. Methods used to meet the goals and requirements of the Owner.
2. Concrete cutting method(s) to be used.
3. Location of construction devices on the site.
4. Show compliance with the use and maintenance of quieted construction devices for the duration of the Project.
5. Indicate activities that may disturb building occupants and that are planned to be performed during non-standard working hours as coordinated with the Owner.

1.4 QUALITY ASSURANCE

- A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.
- C. Accessible Temporary Egress: Comply with applicable provisions in the United States Access Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

1.5 PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Chain-Link Fencing: Minimum 2-inch, 0.148-inch- thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts, with 1-5/8-inch- OD top rails.
- B. Polyethylene Sheet: Reinforced, fire-resistive sheet, 10-mil minimum thickness, with flame-spread rating of 15 or less in accordance with ASTM E84 and passing NFPA 701 Test Method 2.
- C. Dust-Control Adhesive-Surface Walk-Off Mats: Provide mats, minimum 36 by 60 inches.

2.2 TEMPORARY FACILITIES

- A. Field Offices: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
- B. Common-Use Field Office: Of sufficient size to accommodate needs of Owner, Architect, Construction Manager, and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly. Furnish and equip offices as follows:
 1. Furniture required for Project-site documents, including file cabinets, plan tables, plan racks, and bookcases.
 2. Conference room of sufficient size to accommodate meetings of 25 individuals. Provide electrical power service and 120-V ac duplex receptacles, with no fewer than one receptacle on each wall. Furnish room with conference table, chairs, and 4-foot- square tack and marker boards.
 3. Drinking water and private toilet.

4. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F.
 5. Lighting fixtures capable of maintaining average illumination of 20 fc at desk height.
- C. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
1. Store combustible materials apart from building.

2.3 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
 2. Heating, Cooling, and Dehumidifying Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
 3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction and clean HVAC system as required in Section 017700 "Closeout Procedures."

PART 3 - EXECUTION

3.1 TEMPORARY FACILITIES, GENERAL

- A. Conservation: Coordinate construction and use of temporary facilities with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

3.2 INSTALLATION, GENERAL

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
1. Locate facilities to limit site disturbance as specified in Section 011000 "Summary."
- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.3 SITE USE PLAN

- A. Contractor shall confine operations within the areas indicated and as shown on the site use plan and as permitted by law, ordinances, and permits. Site shall not be unreasonably encumbered with materials, products, or construction equipment.

- B. Contractor, in reviewing the use of the site, shall include access to proposed building for construction purposes, parking where possible for employees, temporary facilities including offices, storage, and workshop sheds or portable trailers, utility hookups, staging areas, storage materials and products, and unloading space.
- C. Show additional area needed in the Contractor's use of the site beyond that which may be indicated on the Drawings. Where additional fencing is required, such fencing shall be included at no additional cost to the Owner.

3.4 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.
 - 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Storm Sewers and Storm Drainage: Provide temporary utilities to remove effluent lawfully.
 - 1. Connect temporary storm sewers to municipal system as directed by authorities having jurisdiction.
- C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.
- D. Sanitary Facilities: Provide temporary toilets, wash facilities, safety shower and eyewash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
 - 1. Use of Permanent Toilets: Use of Owner's existing or new toilet facilities is not permitted.
- E. Temporary Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
 - 1. Provide temporary dehumidification systems when required to reduce ambient and substrate moisture levels to level required to allow installation or application of finishes and their proper curing or drying.
- F. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
- G. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
 - 1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
- H. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel.
 - 1. At each telephone, post a list of important telephone numbers.
 - a. Police and fire departments.
 - b. Ambulance service.
 - c. Contractor's home office.
 - d. Contractor's emergency after-hours telephone number.
 - e. Architect's office.

- f. Construction Manager's home office.
 - g. Engineers' offices.
 - h. Owner's office.
 - i. Principal subcontractors' field and home offices.
- I. Electronic Communication Service: Provide secure WiFi wireless connection to internet with provisions for access by Architect and Owner.

3.5 SUPPORT FACILITIES INSTALLATION

- A. Comply with the following:
 - 1. Provide construction for temporary field offices, shops, and sheds located within construction area or within 30 feet of building lines that is noncombustible in accordance with ASTM E136. Comply with NFPA 241.
 - 2. Utilize designated area within existing building for temporary field offices.
 - 3. Maintain support facilities until Architect schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.
- B. Temporary Use of Planned Permanent Roads and Paved Areas: Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.
 - 1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
 - 2. Prepare subgrade and install subbase and base for temporary roads and paved areas in accordance with Section 312000 "Earth Moving."
 - 3. Recondition base after temporary use, including removing contaminated material, regrading, proofrolling, compacting, and testing.
 - 4. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion. Repair hot-mix asphalt base-course pavement before installation of final course in accordance with Section 321216 "Asphalt Paving."
- C. Traffic Controls: Comply with requirements of authorities having jurisdiction.
 - 1. Protect existing site improvements to remain, including curbs, pavement, and utilities.
 - 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- D. Parking: Use designated areas of Owner's existing parking areas for construction personnel.
- E. Storage and Staging: Use designated areas of Project site for storage and staging needs.
- F. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
 - 1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
 - 2. Remove snow and ice as required to minimize accumulations.
- G. Project Signs: Provide Project sign as indicated on sign sample following this Section. Unauthorized signs are not permitted.
 - 1. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
 - a. Provide temporary, directional signs for construction personnel and visitors.

2. Maintain and touch up signs, so they are legible at all times.

- H. Waste Disposal Facilities: Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
- I. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
 - 1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.
- J. Temporary Elevator Use: See Division 14 elevator Section for temporary use of new elevators.
- K. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.
- L. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

3.6 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
 - 1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.
- B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
 - 1. Comply with work restrictions specified in Section 011000 "Summary."
- C. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.
 - 1. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant-protection zones.
 - 2. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
 - 3. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
 - 4. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.
- D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
- E. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.

- F. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals, so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using materials approved by authorities having jurisdiction.
- G. Site Enclosure Fence: Before construction operations begin, furnish and install site enclosure fence in a manner that will prevent people from easily entering site except by entrance gates.
 - 1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.
 - 2. Maintain security by limiting number of keys and restricting distribution to authorized personnel.
- H. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each workday.
- I. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- J. Temporary Egress: Provide temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction. Provide signage directing occupants to temporary egress.
- K. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
 - 1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.
- L. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.
 - 1. Prohibit smoking in construction areas. Comply with additional limits on smoking specified in other Sections.
 - 2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition in accordance with requirements of authorities having jurisdiction.
 - 3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
 - 4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign, stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.7 MOISTURE AND MOLD CONTROL

- A. Moisture and Mold Protection: Protect stored materials and installed Work in accordance with Moisture and Mold Protection Plan.
- B. Exposed Construction Period: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:
 - 1. Protect porous materials from water damage.
 - 2. Protect stored and installed material from flowing or standing water.
 - 3. Keep porous and organic materials from coming into prolonged contact with concrete.
 - 4. Remove standing water from decks.

5. Keep deck openings covered or dammed.
- C. Partially Enclosed Construction Period: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
 2. Keep interior spaces reasonably clean and protected from water damage.
 3. Periodically collect and remove waste containing cellulose or other organic matter.
 4. Discard or replace water-damaged material.
 5. Do not install material that is wet.
 6. Discard and replace stored or installed material that begins to grow mold.
 7. Perform work in a sequence that allows wet materials adequate time to dry before enclosing the material in gypsum board or other interior finishes.
- D. Controlled Construction Period: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
 2. Use temporary or permanent HVAC system to control humidity within ranges specified for installed and stored materials.
 3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.
 - a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for 48 hours are considered defective and require replacing.
 - b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for 48 hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Architect.
 - c. Remove and replace materials that cannot be completely restored to their manufactured moisture level within 48 hours.

3.8 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.
1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.

2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION 015000

NEW HANOVER COUNTY GOVERNMENT CENTER



GK Cape Fear
DEVELOPMENT

FD | STONEWATER

ISP  **Thomas**

Newcomb & Boyd
CONSULTANTS AND ENGINEERS **SEPI**

 **CITADEL**
CONTRACTORS

SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.

1.2 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
 2. New Products: Items that have not previously been incorporated into another project or facility. Salvaged items or items reused from other projects are not considered new products. Items that are manufactured or fabricated to include recycled content materials are considered new products, unless indicated otherwise.
 3. Comparable Product: Product by named manufacturer that is demonstrated and approved through the comparable product submittal process described in Part 2 "Comparable Products" Article, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. Published attributes and characteristics of basis-of-design product establish salient characteristics of products.
1. Evaluation of Comparable Products: In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification.
- C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that does meet the requirements of the specifications; submit a comparable product request or substitution request, if applicable.
- D. Comparable Product Request Submittal: An action submittal requesting consideration of a comparable product, including the following information:
1. Identification of basis-of-design product or fabrication or installation method to be replaced, including Specification Section number and title and Drawing numbers and titles.
 2. Data indicating compliance with the requirements specified in Part 2 "Comparable Products" Article.

- E. Basis-of-Design Product Specification Submittal: An action submittal complying with requirements in Section 013300 "Submittal Procedures."
- F. Substitution: Refer to Section 012500 "Substitution Procedures" for definition and limitations on substitutions.

1.3 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.
 - 1. Resolution of Compatibility Disputes between Multiple Contractors:
 - a. Contractors are responsible for providing products and construction methods compatible with products and construction methods of other contractors.
 - b. If a dispute arises between the multiple contractors over concurrently selectable but incompatible products, Architect will determine which products shall be used.
- B. Identification of Products: Except for required labels and operating data, do not attach or imprint manufacturer or product names or trademarks on exposed surfaces of products or equipment that will be exposed to view in occupied spaces or on the exterior.
 - 1. Labels: Locate required product labels and stamps on a concealed surface, or, where required for observation following installation, on a visually accessible surface that is not conspicuous.
 - 2. Equipment Nameplates: Provide a permanent nameplate on each item of service- or power-operated equipment. Locate on a visually accessible but inconspicuous surface. Include information essential for operation, including the following:
 - a. Name of product and manufacturer.
 - b. Model and serial number.
 - c. Capacity.
 - d. Speed.
 - e. Ratings.
 - 3. See individual identification Sections in Divisions 21, 22, 23, and 26 for additional equipment identification requirements.

1.4 COORDINATION

- A. Modify or adjust affected work as necessary to integrate work of approved comparable products and approved substitutions.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products, using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
 - 1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
 - 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.

3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to determine compliance with the Contract Documents and that products are undamaged and properly protected.

C. Storage:

1. Provide a secure location and enclosure at Project site for storage of materials and equipment.
2. Store products to allow for inspection and measurement of quantity or counting of units.
3. Store materials in a manner that will not endanger Project structure.
4. Store products that are subject to damage by the elements under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation and with adequate protection from wind.
5. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
7. Protect stored products from damage and liquids from freezing.

1.6 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
1. Manufacturer's Warranty: Written standard warranty form furnished by individual manufacturer for a particular product and issued in the name of the Owner or endorsed by manufacturer to Owner.
 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner and issued in the name of the Owner or endorsed by manufacturer to Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 2. Specified Form: When specified forms are included in the Project Manual, prepare a written document, using indicated form properly executed.
 3. See other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Section 017700 "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.

2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Architect will make selection.
5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
6. Or Equal: For products specified by name and accompanied by the term "or equal," "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.
 - a. Submit additional documentation required by Architect through Construction Manager in order to establish equivalency of proposed products. Unless otherwise indicated, evaluation of "or equal" product status is by the Architect, whose determination is final.

B. Product Selection Procedures:

1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Sole product may be indicated by the phrase "Subject to compliance with requirements, provide the following."
2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Sole manufacturer/source may be indicated by the phrase "Subject to compliance with requirements, provide products by the following."
3. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.
 - a. Limited list of products may be indicated by the phrase "Subject to compliance with requirements, provide one of the following."
4. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed or an unnamed product that complies with requirements.
 - a. Non-limited list of products is indicated by the phrase "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following."
 - b. Provision of an unnamed product is not considered a substitution, if the product complies with requirements.
5. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.
 - a. Limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, provide products by one of the following."
6. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed or a product by an unnamed manufacturer that complies with requirements.

- a. Non-limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following."
 - b. Provision of products of an unnamed manufacturer is not considered a substitution, if the product complies with requirements.
- 7. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications may additionally indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
 - a. For approval of products by unnamed manufacturers, comply with requirements in Section 012500 "Substitution Procedures" for substitutions for convenience.
- C. Visual Matching Specification: Where Specifications require the phrase "match Architect's sample," provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
 - 1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 "Substitution Procedures" for proposal of product.
- D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or a similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

- A. Conditions for Consideration of Comparable Products: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with the following requirements:
 - 1. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work.
 - 2. Detailed comparison of significant qualities of proposed product with those of the named basis-of-design product. Significant product qualities include attributes, such as type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.
 - 3. Evidence that proposed product provides specified warranty.
 - 4. List of similar installations for completed projects, with project names and addresses and names and addresses of architects and owners, if requested.
 - 5. Samples, if requested.
- B. Architect's Action on Comparable Products Submittal: If necessary, Architect will request additional information or documentation for evaluation, as specified in Section 013300 "Submittal Procedures."
 - 1. Form of Approval of Submittal: As specified in Section 013300 "Submittal Procedures."
 - 2. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.
- C. Submittal Requirements: Approval by the Architect of Contractor's request for use of comparable product is not intended to satisfy other submittal requirements. Comply with specified submittal requirements.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000

SECTION 017300 - EXECUTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work, including, but not limited to, the following:
 - 1. Construction layout.
 - 2. Installation of the Work.
 - 3. Coordination of Owner's portion of the Work.
 - 4. Progress cleaning.
 - 5. Starting and adjusting.
 - 6. Protection of installed construction.

1.2 PREINSTALLATION MEETINGS

1.3 INFORMATIONAL SUBMITTALS

1.4 QUALITY ASSURANCE

- A. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of specified products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Comply with requirements specified in other Sections.
- B. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.
 - 1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, gas service piping, and water-service piping; underground electrical services; and other utilities.
 - 2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.

- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
 - 1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 - 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 - 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
 - 1. Description of the Work, including Specification Section number and paragraph, and Drawing sheet number and detail, where applicable.
 - 2. List of detrimental conditions, including substrates.
 - 3. List of unacceptable installation tolerances.
 - 4. Recommended corrections.
- D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Existing Utility Information: Furnish information to local utility that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Architect through Construction Manager in accordance with requirements in Section 013100 "Project Management and Coordination."

3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks and existing conditions. If discrepancies are discovered, notify Architect and Construction Manager promptly.
- B. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
- C. Establish limits on use of Project site.
- D. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.

- E. Inform installers of lines and levels to which they must comply.
- F. Check the location, level and plumb, of every major element as the Work progresses.
- G. Notify Architect and Construction Manager when deviations from required lines and levels exceed allowable tolerances.

3.4 INSTALLATION

- A. Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb, and make horizontal work level.
 - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 - 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
 - 4. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied spaces, unless otherwise indicated on Drawings.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure satisfactory results as judged by Architect. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations, so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy of type expected for Project.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on-site and placement in permanent locations.
- F. Tools and Equipment: Select tools or equipment that minimize production of excessive noise levels.
- G. Templates: Obtain and distribute to the parties involved templates for Work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions with manufacturer.
 - 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
 - 2. Allow for building movement, including thermal expansion and contraction.
 - 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- I. Joints: Make joints of uniform width. Where joint locations in exposed Work are not indicated, arrange joints for the best visual effect, as judged by Architect. Fit exposed connections together to form hairline joints.
- J. Repair or remove and replace damaged, defective, or nonconforming Work.

1. Comply with Section 017700 "Closeout Procedures" for repairing or removing and replacing defective Work.

3.5 COORDINATION OF OWNER'S PORTION OF THE WORK

- A. Site Access: Provide access to Project site for Owner's construction personnel and Owner's separate contractors.
- B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel and Owner's separate contractors.
 1. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.
 2. Preinstallation Conferences: Include Owner's construction personnel and Owner's separate contractors at preinstallation conferences covering portions of the Work that are to receive Owner's work. Attend preinstallation conferences conducted by Owner's construction personnel if portions of the Work depend on Owner's construction.

3.6 PROGRESS CLEANING

- A. Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F.
 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
 - a. Use containers intended for holding waste materials of type to be stored.
 4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where Work is in progress to the level of cleanliness necessary for proper execution of the Work.
 1. Remove liquid spills promptly.
 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 017419 "Construction Waste Management and Disposal."
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.7 STARTING AND ADJUSTING

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Manufacturer's Field Service: Comply with qualification requirements in Section 014000 "Quality Requirements."

3.8 PROTECTION AND REPAIR OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Repair Work previously completed and subsequently damaged during construction period. Repair to like-new condition.
- C. Protection of Existing Items: Provide protection and ensure that existing items to remain undisturbed by construction are maintained in condition that existed at commencement of the Work.
- D. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION 017300

SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Recycling nonhazardous construction waste.
 - 2. Disposing of nonhazardous construction waste.

1.2 DEFINITIONS

- A. Construction Waste: Building, structure, and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building, structure, and site improvement materials resulting from demolition operations.
- C. Disposal: Removal of demolition or construction waste and subsequent salvage, sale, recycling, or deposit in landfill, incinerator acceptable to authorities having jurisdiction, or designated spoil areas on Owner's property.
- D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

1.3 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition and construction waste becomes property of Contractor.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with transportation and disposal regulations of authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Contractor is encouraged to recycle as much nonhazardous construction waste as practical, without incurring additional costs to the Owner.

PART 3 - EXECUTION

- A. WASTE MANAGEMENT AND DISPOSAL General: Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
 - 1. Comply with operation, termination, and removal requirements in Section 015000 "Temporary Facilities and Controls."

- B. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.
 - 1. Review plan procedures and locations established for recycling and disposal.
- C. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged and recycled.
 - 2. Comply with Section 015000 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 RECYCLING CONSTRUCTION WASTE, GENERAL

- A. General: Recycle paper and beverage containers used by on-site workers.
- B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Contractor.
- C. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.
- D. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.
 - 1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
 - a. Inspect containers and bins for contamination and remove contaminated materials if found.
 - 2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
 - 4. Store components off the ground and protect from the weather.
 - 5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor as often as required to prevent overfilling bins.

3.3 DISPOSAL OF WASTE

- A. General: Except for items or materials to be salvaged or recycled, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
 - 1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. Burning: Do not burn waste materials.

END OF SECTION 017419

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for Contract closeout, including, but not limited to, the following:
 - 1. Substantial Completion procedures.
 - 2. Final completion procedures.
 - 3. Warranties.
 - 4. Final cleaning.

1.2 DEFINITIONS

- A. List of Incomplete Items: Contractor-prepared list of items to be completed or corrected, prepared for the Architect's use prior to Architect's inspection, to determine if the Work is substantially complete.

1.3 ACTION SUBMITTALS

- A. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.
- B. Certified List of Incomplete Items: Final submittal at Final Completion.

1.4 CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.
- B. Certificate of Insurance: For continuing coverage.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Schedule of Maintenance Material Items: For maintenance material submittal items required by other Sections.

1.6 SUBSTANTIAL COMPLETION PROCEDURES

- A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's "punch list"), indicating the value of each item on the list and reasons why the Work is incomplete.
- B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
 - 1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction, permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 - 2. Submit closeout submittals specified in other Division 01 Sections, including Project Record Documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.

3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Construction Manager. Label with manufacturer's name and model number.
 - a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Construction Manager's signature for receipt of submittals.
 5. Submit testing, adjusting, and balancing records.
 6. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
- C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
1. Advise Owner of pending insurance changeover requirements.
 2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
 3. Complete startup and testing of systems and equipment.
 4. Perform preventive maintenance on equipment used prior to Substantial Completion.
 5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."
 6. Advise Owner of changeover in utility services.
 7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
 8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 9. Complete final cleaning requirements.
 10. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect and Construction Manager will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.
1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
 2. Results of completed inspection will form the basis of requirements for Final Completion.
- 1.7 FINAL COMPLETION PROCEDURES
- A. Submittals Prior to Final Completion: Before requesting final inspection for determining Final Completion, complete the following:
1. Submit a final Application for Payment in accordance with Section 012900 "Payment Procedures."
 2. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.

3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
- B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect and Construction Manager will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
 1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.8 LIST OF INCOMPLETE ITEMS

- A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
 1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor, listed by room or space number.
 2. Organize items applying to each space by major element, including categories for ceilings, individual walls, floors, equipment, and building systems.
 3. Include the following information at the top of each page:
 - a. Project name.
 - b. Date.
 - c. Name of Architect and Construction Manager.
 - d. Name of Contractor.
 - e. Page number.
 4. Submit list of incomplete items in the following format:
 - a. MS Excel Electronic File: Architect, through Construction Manager, will return annotated file.
 - b. Web-Based Project Software Upload: Utilize software feature for creating and updating list of incomplete items (punch list).

1.9 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of warranties might limit Owner's rights under warranty.
- B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.
- C. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
- D. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
 1. Submit on digital media acceptable to Architect.
- E. Warranties in Paper Form:

1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.

F. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
 - a. Clean Project site of rubbish, waste material, litter, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Rake grounds that are not planted, mulched, or paved to a smooth, even-textured surface.
 - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - e. Remove snow and ice to provide safe access to building.
 - f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 - g. Remove debris and surface dust from limited-access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 - h. Clean flooring, removing debris, dirt, and staining; clean according to manufacturer's recommendations.
 - i. Vacuum and mop concrete.
 - j. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
 - k. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - l. Remove labels that are not permanent.

- m. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - n. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - o. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - p. Clean ducts, blowers, and coils that display contamination with particulate matter on inspection.
 - 1) Clean HVAC system in compliance with NADCA ACR. Provide written report on completion of cleaning.
 - q. Clean luminaires, lamps, globes, and reflectors to function with full efficiency.
 - r. Clean strainers.
 - s. Leave Project clean and ready for occupancy.
- C. Pest Control: Comply with pest control requirements in Section 015000 "Temporary Facilities and Controls." Prepare written report.
- D. Construction Waste Disposal: Comply with waste-disposal requirements in Section 017419 "Construction Waste Management and Disposal."

3.2 REPAIR OF THE WORK

- A. Complete repair and restoration operations required by Section 017300 "Execution" before requesting inspection for determination of Substantial Completion.

END OF SECTION 017700

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and maintenance documentation directory manuals.
 - 2. Emergency manuals.
 - 3. Systems and equipment operation manuals.
 - 4. Systems and equipment maintenance manuals.
 - 5. Product maintenance manuals.

1.2 DEFINITIONS

- A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- B. Subsystem: A portion of a system with characteristics similar to a system.

1.3 CLOSEOUT SUBMITTALS

- A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
 - 1. Architect will comment on whether content of operation and maintenance submittals is acceptable.
 - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operation and maintenance manuals in the following format:
 - 1. Submit on digital media acceptable to Architect. Enable reviewer comments on draft submittals.
 - 2. Submit three paper copies of final manual.
- C. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing demonstration and training. Architect will comment on whether general scope and content of manual are acceptable.
- D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Architect will return copy with comments.
 - 1. Correct or revise each manual to comply with Architect's comments. Submit copies of each corrected manual within 15 days of receipt of Architect's comments and prior to commencing demonstration and training.
- E. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

1.4 FORMAT OF OPERATION AND MAINTENANCE MANUALS

- A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.
- B. Manuals, Paper Copy: Submit manuals in the form of hard-copy, bound and labeled volumes.
1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
 - a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
 - b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.
 2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
 3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment. Enclose title pages and directories in clear plastic sleeves.
 4. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
 5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
 - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

1.5 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
1. Title page.
 2. Table of contents.
 3. Manual contents.
- B. Title Page: Include the following information:
1. Subject matter included in manual.
 2. Name and address of Project.

3. Name and address of Owner.
 4. Date of submittal.
 5. Name and contact information for Contractor.
 6. Name and contact information for Construction Manager.
 7. Name and contact information for Architect.
 8. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
 9. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

1.6 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY MANUAL

- A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals. List items and their location to facilitate ready access to desired information. Include the following:
1. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
 2. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
 3. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

1.7 EMERGENCY MANUALS

- A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- B. Content: Organize manual into a separate section for each of the following:
1. Type of emergency.
 2. Emergency instructions.
 3. Emergency procedures.
- C. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
1. Fire.
 2. Flood.
 3. Gas leak.
 4. Water leak.
 5. Power failure.

6. Water outage.
 7. System, subsystem, or equipment failure.
 8. Chemical release or spill.
- D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.
- E. Emergency Procedures: Include the following, as applicable:
1. Instructions on stopping.
 2. Shutdown instructions for each type of emergency.
 3. Operating instructions for conditions outside normal operating limits.
 4. Required sequences for electric or electronic systems.
 5. Special operating instructions and procedures.

1.8 SYSTEMS AND EQUIPMENT OPERATION MANUALS

- A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.
1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
 2. Performance and design criteria if Contractor has delegated design responsibility.
 3. Operating standards.
 4. Operating procedures.
 5. Operating logs.
 6. Wiring diagrams.
 7. Control diagrams.
 8. Piped system diagrams.
 9. Precautions against improper use.
 10. License requirements including inspection and renewal dates.
- C. Descriptions: Include the following:
1. Product name and model number. Use designations for products indicated on Contract Documents.
 2. Manufacturer's name.
 3. Equipment identification with serial number of each component.
 4. Equipment function.
 5. Operating characteristics.
 6. Limiting conditions.
 7. Performance curves.
 8. Engineering data and tests.
 9. Complete nomenclature and number of replacement parts.
- D. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

F. Piped Systems: Diagram piping as installed, and identify color coding where required for identification.

1.9 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds as described below.

C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
 - a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

- E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
 - 1. Test and inspection instructions.
 - 2. Troubleshooting guide.
 - 3. Precautions against improper maintenance.
 - 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - 5. Aligning, adjusting, and checking instructions.
 - 6. Demonstration and training video recording, if available.
- F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
 - 1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
 - 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- I. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.
- J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
 - 1. Do not use original project record documents as part of maintenance manuals.

1.10 PRODUCT MAINTENANCE MANUALS

- A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- D. Product Information: Include the following, as applicable:
 - 1. Product name and model number.
 - 2. Manufacturer's name.
 - 3. Color, pattern, and texture.
 - 4. Material and chemical composition.

5. Reordering information for specially manufactured products.
- E. Maintenance Procedures: Include manufacturer's written recommendations and the following:
1. Inspection procedures.
 2. Types of cleaning agents to be used and methods of cleaning.
 3. List of cleaning agents and methods of cleaning detrimental to product.
 4. Schedule for routine cleaning and maintenance.
 5. Repair instructions.
- F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
1. Include procedures to follow and required notifications for warranty claims.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 017823

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for Project Record Documents, including the following:
 - 1. Record Drawings.

1.2 CLOSEOUT SUBMITTALS

- A. Record Drawings: Submit copies of Record Drawings as follows:
 - 1. Initial Submittal:
 - a. Submit PDF electronic files of scanned record prints and one set(s) of file prints.
 - b. Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
 - 2. Final Submittal:
 - a. Submit PDF electronic files of scanned Record Prints and one set of file prints.
 - b. Print each drawing, whether or not changes and additional information were recorded.
 - 3. Engineered Systems: For Manufacturer/Contractor engineered systems, i.e. fire protection systems, light gauge framing systems, panelized systems, etc., Contractor shall submit two sets of security protected record drawings as follows:
 - a. One in .DWG or acceptable CAD format (write protected);
 - b. One in .PDF format, with seals and signatures.

1.3 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
 - 1. Preparation: Mark record prints to show the actual installation, where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - e. Cross-reference record prints to corresponding photographic documentation.
 - 2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Depths of foundations.
 - d. Locations and depths of underground utilities.
 - e. Revisions to routing of piping and conduits.
 - f. Revisions to electrical circuitry.

- g. Actual equipment locations.
 - h. Duct size and routing.
 - i. Locations of concealed internal utilities.
 - j. Changes made by Change Order or Construction Change Directive.
 - k. Changes made following Architect's written orders.
 - l. Details not on the original Contract Drawings.
 - m. Field records for variable and concealed conditions.
 - n. Record information on the Work that is shown only schematically.
 3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
 4. Mark record prints with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Newly Prepared Record Drawings: Prepare new Drawings instead of preparing record Drawings where Architect determines that neither the original Contract Drawings nor Shop Drawings are suitable to show actual installation.
 1. New Drawings may be required when a Change Order is issued as a result of accepting an alternate, substitution, or other modification.
 2. Consult Architect for proper scale and scope of detailing and notations required to record the actual physical installation and its relation to other construction. Integrate newly prepared record Drawings into record Drawing sets; comply with procedures for formatting, organizing, copying, binding, and submitting.
- C. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
 1. Record Prints: Organize record prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 2. Format: Annotated PDF electronic file with comment function enabled.
 3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
 4. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT RECORD DRAWINGS."
 - d. Name of Architect and Construction Manager.
 - e. Name of Contractor.

1.4 MAINTENANCE OF RECORD DOCUMENTS

- A. Maintenance of Record Documents: Store Record Documents in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Architect's and Construction Manager's reference during normal working hours.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 017839

SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
 - 1. Instruction in operation and maintenance of systems, subsystems, and equipment.

1.2 INFORMATIONAL SUBMITTALS

- A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
- B. Qualification Data: For facilitator and instructor.
- C. Attendance Record: For each training module, submit list of participants and length of instruction time.
- D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

1.3 QUALITY ASSURANCE

- A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures and training.

1.4 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data have been reviewed and approved by Architect.

1.5 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
 - a. System, subsystem, and equipment descriptions.
 - b. Performance and design criteria if Contractor is delegated design responsibility.
 - c. Operating standards.
 - d. Regulatory requirements.
 - e. Equipment function.
 - f. Operating characteristics.
 - g. Limiting conditions.
 - h. Performance curves.
 2. Documentation: Review the following items in detail:
 - a. Emergency manuals.
 - b. Systems and equipment operation manuals.
 - c. Systems and equipment maintenance manuals.
 - d. Product maintenance manuals.
 - e. Project Record Documents.
 - f. Identification systems.
 - g. Warranties and bonds.
 - h. Maintenance service agreements and similar continuing commitments.
 3. Emergencies: Include the following, as applicable:
 - a. Instructions on meaning of warnings, trouble indications, and error messages.
 - b. Instructions on stopping.
 - c. Shutdown instructions for each type of emergency.
 - d. Operating instructions for conditions outside of normal operating limits.
 - e. Sequences for electric or electronic systems.
 - f. Special operating instructions and procedures.
 4. Operations: Include the following, as applicable:
 - a. Startup procedures.
 - b. Equipment or system break-in procedures.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Control sequences.
 - f. Safety procedures.
 - g. Instructions on stopping.
 - h. Normal shutdown instructions.
 - i. Operating procedures for emergencies.
 - j. Operating procedures for system, subsystem, or equipment failure.
 - k. Seasonal and weekend operating instructions.
 - l. Required sequences for electric or electronic systems.
 - m. Special operating instructions and procedures.
 5. Adjustments: Include the following:
 - a. Alignments.
 - b. Checking adjustments.
 - c. Noise and vibration adjustments.
 - d. Economy and efficiency adjustments.
 6. Troubleshooting: Include the following:
 - a. Diagnostic instructions.

- b. Test and inspection procedures.
- 7. Maintenance: Include the following:
 - a. Inspection procedures.
 - b. Types of cleaning agents to be used and methods of cleaning.
 - c. List of cleaning agents and methods of cleaning detrimental to product.
 - d. Procedures for routine cleaning.
 - e. Procedures for preventive maintenance.
 - f. Procedures for routine maintenance.
 - g. Instruction on use of special tools.
- 8. Repairs: Include the following:
 - a. Diagnosis instructions.
 - b. Repair instructions.
 - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - d. Instructions for identifying parts and components.
 - e. Review of spare parts needed for operation and maintenance.

1.6 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operation and Maintenance Data."
- B. Set up instructional equipment at instruction location.

1.7 INSTRUCTION

- A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.
- B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1. Owner will furnish Contractor with names of participants.
- C. Scheduling: Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
 - 1. Schedule training with Owner, through Construction Manager, with at least seven days' advance notice.
- D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.
- E. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a demonstration performance-based test.

PART 2 - PRODUCTS

PART 3 - EXECUTION

END OF SECTION 017900

SECTION 061053 - MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Wood blocking, cants, and nailers.
 2. Raised platform sheathing.
 3. Plywood backing panels.

1.2 DEFINITIONS

- A. Boards or Strips: Lumber of less than 2 inches nominal size in least dimension.
- B. Dimension Lumber: Lumber of 2 inches nominal or greater size but less than 5 inches nominal size in least dimension.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
 2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
 3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5664.
 4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.4 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For the following, from ICC-ES:
1. Preservative-treated wood.
 2. Fire-retardant-treated wood.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
 - 1. Factory mark each piece of lumber with grade stamp of grading agency.
 - 2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
 - 3. Dress lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content of Lumber: 15 percent for 2-inch nominal thickness or less, 19 percent for more than 2-inch nominal thickness unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWP A U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.
 - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
 - 2. For exposed items indicated to receive a stained or natural finish, chemical formulations shall not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- D. Application: Treat items indicated on Drawings, and the following:
 - 1. Wood cants, nailers, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 - 2. Wood blocking, stripping, and similar concealed members in contact with masonry or concrete.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
 - 1. Treatment shall not promote corrosion of metal fasteners.
 - 2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
 - 3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201 at 92 percent relative humidity. Use where exterior type is not indicated.
- C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.
- D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
 - 1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
- E. For exposed items indicated to receive a stained or natural finish, chemical formulations shall not bleed through, contain colorants, or otherwise adversely affect finishes.
- F. Application: Treat items indicated on Drawings, and the following:
 - 1. Concealed blocking.
 - 2. Wood cants, nailers, blocking, and similar members in connection with roofing.
 - 3. Raised platform sheathing.
 - 4. Plywood backing panels.

2.4 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 - 1. Blocking.
 - 2. Nailers.
 - 3. Cants.
- B. Dimension Lumber Items: Construction or No. 2 grade lumber of any species.
- C. Concealed Boards: 19 percent maximum moisture content of any of the following species and grades:
 - 1. Mixed southern pine or southern pine, No. 2 grade; SPIB.
 - 2. Spruce-pine-fir (south) or spruce-pine-fir, Construction or No. 2 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
 - 3. Eastern softwoods, No. 2 Common grade; NELMA.
- D. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- E. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.5 RAISED PLATFORM SHEATHING

- A. Composite Wood Products: Provide fire-retardant treated materials that comply with requirements of the Architectural Woodwork Standards for each type of interior architectural woodwork and quality grade specified unless otherwise indicated.
 - 1. Softwood Plywood: DOC PS 1, medium-density overlay.
 - 2. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1.

2.6 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: Plywood, DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 1/2-inch nominal thickness.

2.7 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners of Type 304 stainless steel.
- B. Nails, Brads, and Staples: ASTM F1667.
- C. Screws for Fastening to Metal Framing: ASTM C954, length as recommended by screw manufacturer for material being fastened.

2.8 MISCELLANEOUS MATERIALS

- A. Flexible Flashing: Composite, self-adhesive, high-temperature flashing product consisting of a pliable, butyl or SBS-modified asphalt compound, bonded to a high-density polyethylene film to produce an overall thickness of not less than 30 mils.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry accurately to other construction. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- B. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.
- C. Do not splice structural members between supports unless otherwise indicated.
- D. Provide blocking as indicated and as required to support facing materials, fixtures, specialty items, and trim.
- E. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:

1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
- F. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- G. Comply with AWPAC M4 for applying field treatment to cut surfaces of preservative-treated lumber.
 1. Use inorganic boron for items that are continuously protected from liquid water.
 2. Use copper naphthenate for items not continuously protected from liquid water.
- H. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- I. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
 2. ICC-ES evaluation report for fastener.
- J. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 INSTALLATION OF WOOD BLOCKING AND NAILER

- A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

3.3 PROTECTION

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
- B. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061053

SECTION 064116 - PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plastic-laminate-clad architectural cabinets and wall mounted shelves.
2. Acrylic resin 3D panels.
3. Cabinet hardware and accessories.
4. Wood furring, blocking, shims, and hanging strips for installing plastic-laminate-clad architectural cabinets that are not concealed within other construction.

1.2 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to support loads imposed by installed and fully loaded cabinets.
- B. Hardware Coordination: Distribute copies of approved hardware schedule specified in Section 087100 "Door Hardware" to manufacturer of architectural cabinets; coordinate Shop Drawings and fabrication with hardware requirements.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
- B. Shop Drawings:
 1. Include plans, elevations, sections, and attachment details.
 2. Show large-scale details.
 3. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 4. Show locations and sizes of cutouts and holes for items installed in plastic-laminate architectural cabinets.
- C. Samples: For each exposed product and for each color and texture specified, in manufacturer's or manufacturer's standard size.
- D. Samples for Initial Selection: For each type of exposed finish.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Product Certificates: For each type of product.

- C. Evaluation Reports: For fire-retardant-treated materials, from ICC-ES.
- D. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
 - 1. Manufacturer's Certification: Licensed participant in AWT's Quality Certification Program.
- B. Installer Qualifications: Manufacturer of products.
- C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Build mockups of typical architectural cabinets as shown on Drawings.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver cabinets until painting and similar finish operations that might damage architectural cabinets have been completed in installation areas. Store cabinets in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.8 FIELD CONDITIONS

- A. Environmental Limitations without Humidity Control: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.
- B. Field Measurements: Where cabinets are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed/concealed by construction, and indicate measurements on Shop Drawings.
- C. Established Dimensions: Where cabinets are indicated to fit to other construction, establish dimensions for areas where cabinets are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 ARCHITECTURAL CABINET MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cabinets by Design, Duluth, GA
 - 2. Cleora Sterling
 - 3. LSI Corporation
 - 4. Pridgen Millwork

5. Stephenson Millwork
6. Stevens Industries, Inc.

2.2 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

- A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of cabinets indicated for construction, finishes, installation, and other requirements.
 1. The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with requirements of Contract Documents in addition to those of the referenced quality standard.
- B. Architectural Woodwork Standards Grade: Custom.
- C. Type of Construction: Frameless.
- D. Door and Drawer-Front Style: Flush overlay.
- E. High-Pressure Decorative Laminate (**PLM-2, PLM-4, PLM-7**): NEMA LD 3, grades as indicated or if not indicated, as required by quality standard.
 1. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
 - a. Formica Corporation
 - b. Pionite; a Panolam Industries International, Inc. brand.
 - c. Nevamar
 - d. Wilsonart
 2. Colors, Patterns, and Finishes: As selected by Architect from laminate manufacturer's full range.
- F. Laminate Cladding for Exposed Surfaces:
 1. Horizontal Surfaces: Grade HGS.
 2. Postformed Surfaces: Grade HGP.
 3. Vertical Surfaces: Grade VGS.
 4. Edges: Grade HGS or Grade VGS.
 5. Pattern Direction: Vertically for drawer fronts, doors, and fixed panels.
- G. Materials for Semiexposed Surfaces:
 1. Surfaces Other Than Drawer Bodies: Thermally fused laminate panels.
 - a. Edges of Plastic-Laminate Shelves: PVC tape, 0.018-inch minimum thickness, matching laminate in color, pattern, and finish.
 - b. Edges of Thermally Fused Laminate Panel Shelves: PVC or polyester edge banding.
 - c. For semiexposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, NEMA LD 3, Grade VGS.
 2. Drawer Sides and Backs: Thermally fused laminate panels with PVC or polyester edge banding.
 3. Drawer Bottoms: Hardwood plywood.
- H. Dust Panels: 1/4-inch plywood or tempered hardboard above compartments and drawers unless located directly under tops.
- I. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade BKL.

- J. Cabinet Construction: As required by referenced quality standard, but not less than the following:
1. Bottoms and Ends of Cabinets, and Tops of Wall Cabinets and Tall Cabinets: 3/4-inch particleboard, plastic-laminate faced on exposed surfaces, thermoset decorative panels on semiexposed surfaces.
 2. Cabinet Joinery: Fixed body members shall be joined using dowels and assembled using glue and pressure.
 3. Shelves: 3/4-inch thick particleboard, plastic-laminate faced or thermoset decorative panels.
 4. Backs of Cabinets: 1/2-inch particleboard, plastic-laminate faced on exposed surfaces, thermoset decorative panels on semiexposed surfaces.
 5. Drawer Fronts: 3/4-inch particleboard, plastic-laminate faced.
 6. Drawer Sides and Backs: 1/2-inch particleboard or MDF, plastic-laminate faced, with glued dovetail or multiple-dowel joints.
 7. Drawer Bottoms: 1/2-inch particleboard or MDF, plastic-laminate faced, glued and dadoed into front, back, and sides of drawers.
 8. Doors: 3/4-inch particleboard or MDF, plastic-laminate faced.

2.3 WOOD MATERIALS

- A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
1. Wood Moisture Content: 5 to 10 percent.
- B. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
1. Medium-Density Fiberboard (MDF): ANSI A208.2, Grade 130.
 2. Particleboard (Medium Density): ANSI A208.1, Grade M-2 or Grade M-2-Exterior Glue.
 3. Softwood Plywood: DOC PS 1, medium-density overlay.
 4. Thermally Fused Laminate (TFL) Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD 3, Grade VGL, for Test Methods 3.3, 3.4, 3.6, 3.8, and 3.10.

2.4 ACRYLIC RESIN PANELS

- A. Acrylic Resin Panels (**ACR-1**): 3D sculpted acrylic resin panel trimmed with metal edge.
1. Products: Subject to compliance with requirements, provide one of the following products:
 - a. 3Form; Meridian (Basis of Design).
 - b. Soelberg; Mare
 2. Color: As indicated on Material Finishes Legend.
 3. Metal Edge (**TRM-3**):
 - a. Basis of Design: Fry Reglet; Product as indicated on Material Finishes Legend.
 - b. Material: Aluminum.
 - c. Finish: Clear anodized, Class II.
 4. Installation:
 - a. Install resin panels horizontally.
 - b. Double-Sided Tape: Install resin panels with 3M VHB double-sided tape, or a manufacturer approved double-sided tape. Align panels prior to curing of tape.

2.5 FIRE-RETARDANT-TREATED MATERIALS

- A. Fire-Retardant-Treated Materials, General: Where fire-retardant-treated materials are indicated, use materials that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products in accordance with test method indicated by a qualified testing agency.
1. Use treated materials that comply with requirements of referenced quality standard. Do not use materials that are warped, discolored, or otherwise defective.
 2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
 3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.
- B. Fire-Retardant-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested according to ASTM E84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
1. Kiln-dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.
 2. For items indicated to receive a stained or natural finish, use organic resin chemical formulation.
 3. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking shop certified by testing and inspecting agency.
 4. Mill lumber before treatment and implement procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of architectural cabinets.
- C. Fire-Retardant Particleboard: Made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less in accordance with ASTM E84.
1. For panels 3/4 inch thick and less, comply with ANSI A208.1 for Grade M-2 except for the following minimum properties: modulus of rupture, 1600 psi; modulus of elasticity, 300,000 psi; internal bond, 80 psi; and screw-holding capacity on face and edge, 250 and 225 lbf, respectively.
 2. For panels 13/16 to 1-1/4 inches thick, comply with ANSI A208.1 for Grade M-1 except for the following minimum properties: modulus of rupture, 1300 psi; modulus of elasticity, 250,000 psi; linear expansion, 0.50 percent; and screw-holding capacity on face and edge, 250 and 175 lbf, respectively.
- D. Fire-Retardant Fiberboard: MDF panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less in accordance with ASTM E84.

2.6 CABINET HARDWARE AND ACCESSORIES

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets except for items specified in Section 087100 "Door Hardware."
- B. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, B01602, 100 degrees of opening, soft-closing.
- C. Back-Mounted Pulls: ANSI/BHMA A156.9, B02011.

- D. Shelf Rests: ANSI/BHMA A156.9, B04013; metal.
- E. Wall Mounted Shelf Brackets: Heavy duty workstation brackets. Under-counter support frames, legs and miscellaneous metal parts shall be aluminum or steel, welded, degreased, cleaned, treated and powder-coated.
- F. Drawer Slides: ANSI/BHMA A156.9.
 - 1. Heavy-Duty (Grade 1HD-100 and Grade 1HD-200): Undermount.
 - a. Type: Full extension.
 - b. Material: Stainless steel slides.
 - c. Motion Feature: Soft close dampener.
 - 2. Pencil drawers not more than 3 inches high and not more than 24 inches wide, provide 50 lb load capacity.
 - 3. General-purpose drawers more than 3 inches high, but not more than 6 inches high and not more than 24 inches wide, provide 100 lb load capacity.
 - 4. File drawers more than 6 inches high or more than 24 inches wide, provide 100 lb load capacity.
 - 5. Computer keyboard tray, provide 75 lb load capacity.
- G. Door Locks: ANSI/BHMA A156.11, E07121.
- H. Drawer Locks: ANSI/BHMA A156.11, E07041.
- I. Door and Drawer Silencers: ANSI/BHMA A156.16, L03011.
- J. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with ANSI/BHMA A156.18 for ANSI/BHMA finish number indicated.
 - 1. Satin Stainless Steel: ANSI/BHMA 630.
- K. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in ANSI/BHMA A156.9.

2.7 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.
 - 1. Provide fire-retardant-treated softwood lumber where required.
- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.
- C. Adhesive for Bonding Plastic Laminate: Manufacturer's standard.

2.8 FABRICATION

- A. Fabricate architectural cabinets to dimensions, profiles, and details indicated.
- B. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

1. Notify Architect seven days in advance of the dates and times architectural cabinet fabrication will be complete.
 2. Trial fit assemblies at manufacturer's shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.
- C. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.

3.2 INSTALLATION

- A. Architectural Woodwork Standards Grade: Install cabinets to comply with quality standard grade of item to be installed.
- B. Assemble cabinets and complete fabrication at Project site to extent that it was not completed in the shop.
- C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with wafer-head cabinet installation screws.
- D. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches using concealed shims.
1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
 2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
 3. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches o.c. with No. 10 wafer-head screws sized for not less than 1-1/2-inch penetration into wood framing, blocking, or hanging strips.

3.3 ADJUSTING AND CLEANING

- A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects. Where not possible to repair, replace architectural cabinets. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean cabinets on exposed and semiexposed surfaces.

END OF SECTION 064116

SECTION 071800 - TRAFFIC COATINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes traffic coatings for the following applications:
 - 1. Equipment-room floor.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include installation instructions and details, material descriptions, dry or wet film thickness requirements, and finish.
- B. Shop Drawings: For traffic coatings.
 - 1. Include details for treating substrate joints and cracks, flashings, deck penetrations, and other termination conditions that are not included in manufacturer's product data.
- C. Samples for Initial Selection: For each type of exposed finish.
- D. Samples for Verification: For each type of exposed finish, prepared on rigid backing.
 - 1. Provide stepped Samples on backing to illustrate buildup of traffic coatings.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For each type of traffic coating.
- C. Field quality-control reports.
- D. Sample Warranty: For manufacturer's warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For traffic coatings to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Mockups: Build mockups to set quality standards for materials and execution.

1. Build mockup for each traffic coating and substrate to receive traffic coatings.
2. Size: 100 sq. ft. of each substrate to demonstrate surface preparation, joint and crack treatment, thickness, texture, color, and standard of workmanship.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Apply traffic coatings within the range of ambient and substrate temperatures recommended in writing by manufacturer. Do not apply traffic coatings to damp or wet substrates, when temperatures are below 40 deg F, when relative humidity exceeds 85 percent, or when temperatures are less than 5 deg F above dew point.
1. Do not apply traffic coatings in snow, rain, fog, or mist, or when such weather conditions are imminent during the application and curing period. Apply only when frost-free conditions occur throughout the depth of substrate.
- B. Do not install traffic coating until items that penetrate membrane have been installed.

1.8 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace traffic coating that fails in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Adhesive or cohesive failures.
 - b. Abrasion or tearing failures.
 - c. Surface crazing or spalling.
 - d. Intrusion of water, oils, gasoline, grease, salt, deicer chemicals, or acids into deck substrate.
 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations:
1. Obtain traffic coatings from single source from single manufacturer.
 2. Obtain primary traffic-coating materials, including primers, from traffic-coating manufacturer. Obtain accessory materials including aggregates, sheet flashings, joint sealants, and substrate repair materials of types and from sources recommended in writing by primary material manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Material Compatibility: Provide primers; base coat, intermediate coat, and topcoat; and accessory materials that are compatible with one another and with substrate under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

2.3 TRAFFIC COATING

- A. Traffic Coating: Manufacturer's standard, traffic-bearing, seamless, high-solids-content, cold liquid-applied, elastomeric, water-resistant membrane system with integral wearing surface for equipment-room floor service condition; according to ASTM C957/C957M.
 - 1. Basis of Design: Subject to compliance with requirements, provide basis of design indicated or comparable product by one of the following:
 - a. Tremco Incorporated; Vulkem 350NF/950NF (Basis of Design)
 - b. BASF Construction Chemicals, LLC - Building Systems
 - c. Carlisle Coatings & Waterproofing Inc.
 - d. Euclid Chemical Company
 - e. Gaco Western LLC
 - f. Pecora Corporation
- B. Primer: Liquid primer as recommended in writing for substrate and conditions by traffic-coating manufacturer.
 - 1. Material: Polyurethane.
- C. Preparatory and Base Coats: Polyurethane.
 - 1. Thicknesses: Minimum dry- or wet- film thickness as recommended in writing by manufacturer for substrate and service conditions indicated.
- D. Intermediate Coat: Polyurethane.
 - 1. Thicknesses: Minimum dry- or wet- film thickness as recommended in writing by manufacturer for substrate and service conditions indicated, measured excluding aggregate.
 - 2. Aggregate Content: As recommended in writing by traffic-coating manufacturer for substrate and service conditions indicated.
- E. Topcoat: Polyurethane.
 - 1. Thicknesses: Minimum dry- or wet- film thickness as recommended in writing by manufacturer for substrate and service conditions indicated, measured excluding aggregate.
 - 2. Aggregate Content: As recommended in writing by traffic-coating manufacturer for substrate and service conditions indicated.
 - 3. Color: As selected by Architect from manufacturer's full range.
- F. Aggregate: Manufacturer's standard aggregate for each use indicated of particle sizes, shape, and minimum hardness recommended in writing by traffic-coating manufacturer.

2.4 ACCESSORY MATERIALS

- A. Joint Sealants: As specified in Section 079200 "Joint Sealants."
- B. Sheet Flashing: Nonstaining sheet material recommended in writing by traffic-coating manufacturer.
 - 1. Thickness: Minimum 60 mils.
- C. Adhesive: Contact adhesive recommended in writing by traffic-coating manufacturer.
- D. Reinforcing Strip: Fiberglass mesh recommended in writing by traffic-coating manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, surface smoothness, and other conditions affecting performance of traffic-coating work.
- B. Verify that substrates are visibly dry and free of moisture.
 - 1. Test for moisture content by method recommended in writing by traffic-coating manufacturer.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of traffic-coating work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Begin coating application only after substrate construction and penetrating work have been completed.
 - 2. Begin coating application only after minimum concrete-curing and -drying period recommended in writing by traffic-coating manufacturer has passed and after substrates are dry.
 - 3. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Clean and prepare substrates according to ASTM C1127 and manufacturer's written instructions to produce clean, dust-free, dry substrate for traffic-coating application. Remove projections, fill voids, and seal joints if any, as recommended in writing by traffic-coating manufacturer.
- B. Priming: Unless manufacturer recommends in writing against priming, prime substrates according to manufacturer's written instructions.
 - 1. Limit priming to areas that will be covered by traffic-coating material on same day. Reprime areas exposed for more time than recommended by manufacturer.
- C. Schedule preparation work so dust and other contaminants from process do not fall on wet, newly coated surfaces.
- D. Mask adjoining surfaces not receiving traffic coatings to prevent overspray, spillage, leaking, and migration of coatings. Prevent traffic-coating materials from entering deck substrate penetrations and clogging weep holes and drains.
- E. Concrete Substrates: Mechanically abrade surface to a uniform profile acceptable to manufacturer, according to ASTM D4259. Do not acid etch.
 - 1. Remove grease, oil, paints, and other penetrating contaminants from concrete.
 - 2. Remove concrete fins, ridges, and other projections.
 - 3. Remove laitance, glaze, efflorescence, curing compounds, concrete hardeners, form-release agents, and other incompatible materials that might affect coating adhesion.
 - 4. Remove remaining loose material to provide a sound surface, and clean surfaces according to ASTM D4258.

3.3 TERMINATIONS AND PENETRATIONS

- A. Prepare vertical and horizontal surfaces at terminations and penetrations through traffic coatings and at expansion joints, drains, and sleeves according to ASTM C1127 and manufacturer's written instructions.
- B. Provide sealant cants at penetrations and at reinforced and nonreinforced, deck-to-wall butt joints.
- C. Terminate edges of deck-to-deck expansion joints with preparatory base-coat strip.
- D. Install sheet flashings at deck-to-wall expansion and dynamic joints, and bond to deck and wall substrates according to manufacturer's written recommendations.

3.4 JOINT AND CRACK TREATMENT

- A. Prepare, treat, rout, and fill joints and cracks in substrates according to ASTM C1127 and manufacturer's written recommendations. Before coating surfaces, remove dust and dirt from joints and cracks according to ASTM D4258.
 - 1. Comply with recommendations in ASTM C1193 for joint-sealant installation.
- B. Apply reinforcing strip in traffic-coating system where recommended in writing by traffic-coating manufacturer.

3.5 TRAFFIC-COATING APPLICATION

- A. Apply traffic coating according to ASTM C1127 and manufacturer's written instructions.
- B. Apply coats of specified compositions for each type of traffic coating at locations as indicated on Drawings.
- C. Start traffic-coating application in presence of manufacturer's technical representative.
- D. Verify that wet-film thickness of each coat complies with requirements every 100 sq. ft.
- E. Uniformly broadcast and embed aggregate in each coat indicated to receive aggregate according to manufacturer's written instructions. After coat dries, sweep away excess aggregate.
- F. Apply traffic coatings to prepared wall terminations and vertical surfaces to height indicated; omit aggregate on vertical surfaces.
- G. Cure traffic coatings. Prevent contamination and damage during coating application and curing.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Owner may engage a qualified testing agency to perform the following field tests and inspections:
 - 1. Materials Testing:
 - a. Samples of material delivered to Project site shall be taken, identified, sealed, and certified in presence of Owner and Contractor.
 - b. Testing agency shall perform tests for characteristics specified, using applicable referenced testing procedures.

- c. Testing agency shall verify thickness of coatings during traffic-coating application for each 600 sq. ft. of installed traffic coating or part thereof.
 - B. Final Traffic-Coating Inspection: Arrange for traffic-coating manufacturer's technical personnel to inspect membrane installation on completion.
 - 1. Notify Architect or Owner 48 hours in advance of date and time of inspection.
 - C. Waterproofing will be considered defective if it does not pass tests and inspections.
 - D. Prepare test and inspection reports.
- 3.7 PROTECTING AND CLEANING
- A. Protect traffic coatings from damage and wear during remainder of construction period.
 - B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 071800

SECTION 077129 - MANUFACTURED ROOF EXPANSION JOINTS

1.1 SUMMARY

- A. Section Includes:
 - 1. Flanged bellows-type roof expansion joints.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project Site

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For roof expansion joints.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include details of splices, intersections, transitions, fittings, method of field assembly, and location and size of each field splice.
 - 3. Provide isometric drawings of intersections, terminations, changes in joint direction or planes, and transition to other expansion joint systems depicting how components interconnect with each other and adjacent construction to allow movement and achieve waterproof continuity.
- C. Samples: For each exposed product and for each color specified, 6 inches in size.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample Warranties: For special warranties.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Installer of roofing membrane.

1.6 WARRANTY

- A. Special Warranty: Manufacturer and Installer agree to repair or replace roof expansion joints and components that leak, deteriorate beyond normal weathering, or otherwise fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace roof expansion joints that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint seals, failure of connections, and other detrimental effects.
1. Temperature Change: 120 deg F, material surfaces.

2.2 FLANGED BELLOWS-TYPE ROOF EXPANSION JOINTS

- A. Flanged Bellows-Type Roof Expansion Joint: Factory-fabricated, continuous, waterproof, joint cover consisting of exposed membrane bellows laminated to flexible, closed-cell support foam, and secured along each edge to 3- to 4-inch- wide metal flange.
1. Source Limitations: Obtain flanged bellows-type roof expansion joints approved by roofing manufacturer and that are part of roofing membrane warranty.
 2. Joint Movement Capability: Plus and minus 50 percent of joint size.
 3. Bellows: PVC flexible membrane, nominal 60 milsthick.
 4. Flanges: Stainless steel, 0.0188 inchthick or Aluminum, 0.032 inchthick
 5. Configuration: Roof to Wall.
 6. Corner, Intersection, and Transition Units: Provide factory-fabricated units for corner and joint intersections and horizontal and vertical transitions including those to other building expansion joints.
 - a. Color: White.
 7. Accessories: Provide splicing units, adhesives, and other components as recommended by roof-expansion-joint manufacturer for complete installation.
 - a. Thermal Insulation: Fill space above secondary seal with manufacturer's standard insulation; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E84.
- B. Materials:
1. Galvanized-Steel Sheet: ASTM A653/A653M, hot-dip zinc-coating designation G90.
 2. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.
 3. Aluminum Sheet: ASTM B209, mill finish, with temper to suit forming operations and performance required.
 - a. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious or preservative-treated wood materials.
 4. PVC Membrane: ASTM D4434/D4434M, type standard with manufacturer for application.

2.3 MISCELLANEOUS MATERIALS

- A. Adhesives: As recommended by roof-expansion-joint manufacturer.
- B. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to withstand design loads.
1. Exposed Fasteners: Gasketed. Use screws with hex washer heads matching color of material being fastened.
- C. Mineral-Fiber Blanket: ASTM C665.

- D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joint openings, substrates, and expansion-control joint systems that interface with roof expansion joints, for suitable conditions where roof expansion joints will be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Comply with manufacturer's written instructions for handling and installing roof expansion joints.
1. Anchor roof expansion joints securely in place, with provisions for required movement. Use fasteners, protective coatings, sealants, and miscellaneous items as required to complete roof expansion joints.
 2. Install roof expansion joints true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
 3. Provide for linear thermal expansion of roof-expansion-joint materials.
 4. Provide uniform profile of roof expansion joint throughout its length; do not stretch or squeeze membranes.
 5. Provide uniform, neat seams.
 6. Install roof expansion joints to fit substrates and to result in watertight performance.
- B. Directional Changes: Install factory-fabricated units at directional changes to provide continuous, uninterrupted, and watertight joints.
- C. Transitions to Other Expansion-Control Joint Assemblies: Coordinate installation of roof expansion joints with other exterior expansion-control joint assemblies specified in Section 079513.16 "Exterior Expansion Joint Cover Assemblies" to result in watertight performance. Install factory-fabricated units at transitions between roof expansion joints and exterior expansion-control joint systems.
- D. Splices: Splice roof expansion joints to provide continuous, uninterrupted, and waterproof joints.

END OF SECTION 077129

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes through-penetration firestop systems for penetrations through the following fire-resistance-rated assemblies, including both empty openings and openings containing penetrating items:
 - 1. Floors.
 - 2. Roofs.
 - 3. Walls and partitions.
- B. Related Sections:
 - 1. Section 078446 "Fire-Resistive Joint Systems" for joints in or between fire-resistance-rated construction and in smoke barriers.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1.
 - 1. Before installation of fire-resistance-rated assemblies and penetrating items, review through-penetration firestop system and examine procedures for ensuring quality of installed systems. Require representatives of each entity directly concerned with through-penetration firestop system to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for through-penetration firestop system.
 - c. Through-penetration firestop system Manufacturer's service representative.
 - d. Through-penetration firestop system Installer.
 - e. Fire-resistance-rated masonry Installer.
 - f. Fire-resistance-rated gypsum board assembly Installer.
 - g. Mechanical piping Installer.
 - h. HVAC ductwork Installer.
 - i. Electrical wireway Installer.
 - 2. Review inspection and testing and inspecting agency procedures for field quality control, through-penetration firestop system installation, and coordination of penetrating item configurations with available rated through-penetration firestop system assemblies.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of through-penetration firestop system product indicated.
- B. Shop Drawings: For each through-penetration firestop system, show each kind of construction condition penetrated, relationships to adjoining construction, and kind of penetrating item. Include firestop design designation of testing and inspecting agency acceptable to authorities having jurisdiction that evidences compliance with requirements for each condition indicated.
 - 1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop system configuration for construction and penetrating items.
 - 2. Where Project conditions require modification of qualified testing and inspecting agency's illustration to suit a particular through-penetration firestop condition, submit illustration, with

modifications marked, approved by through-penetration firestop system manufacturer's fire-protection engineer.

- a. Engineer shall be legally qualified to practice in the state in which the project is located.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- B. Product Certificates: Signed by manufacturers of through-penetration firestop system products certifying that products furnished comply with requirements.
- C. Product Test Reports: From a qualified testing agency indicating through-penetration firestop system complies with requirements, based on comprehensive testing of current products.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain through-penetration firestop systems from a single manufacturer.
- B. Installer's Qualifications: An experienced installer who is qualified by having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Firm shall hold current certification by third party attesting to its ability to select and install firestopping in accordance with performance requirements, have established management system for firestopping and employ trained supervisor (DRI) to maintain oversight of firestopping installation.
 1. Certification for firestopping firms: Firm shall be certified by one of the following:
 - a. Factory Mutual Global: FM Standard 4991.
 - b. UL Qualified Firestop Contractor.
 2. Qualification for Superintendent: Superintendent shall have a minimum of 3 years experience in firestopping.
 3. Qualification for Firestop Installer: Trained individual in accordance with requirements of certification of firm.
 - a. Firestop Installers Training (FIT) Level 1 by Specified Technologies, Inc.
 - b. Certified 3M Trained by 3M Fire Protection Products.
 - c. Hilti Basic Firestop Training
 - d. Similar training by manufacturers listed in Part 2.
 4. A manufacturer's willingness to sell its through-penetration firestop system products to Contractor or to an installer engaged by Contractor does not in itself confer qualification on buyer.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Ventilate through-penetration firestop systems per manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.

1.7 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.
- C. Notify Owner's inspecting agency at least seven days in advance of through-penetration firestop system installations; confirm dates and times on days preceding each series of installations.
- D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until Owner's inspecting agency and building inspector, if required by authorities having jurisdiction, have examined each installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General: For the following constructions, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assembly penetrated.
 - 1. Fire-resistance-rated load-bearing walls, including partitions, with fire-protection-rated openings.
 - 2. Fire-resistance-rated non-load-bearing walls, including partitions, with fire-protection-rated openings.
 - 3. Fire-resistance-rated floor assemblies.
 - 4. Fire-resistance-rated roof assemblies.
 - 5. Smoke barriers.
- B. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, as determined per ASTM E 814, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
- C. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings, as determined per ASTM E 814, where systems protect penetrating items exposed to potential contact with adjacent materials in occupiable floor areas:
 - 1. Penetrations located outside wall cavities.
 - 2. Penetrations located outside fire-resistive shaft enclosures.
 - 3. Penetrations located in construction containing fire-protection-rated openings.
 - 4. Penetrating items larger than 4-inch- diameter nominal pipe or 16 sq. in. in overall cross-sectional area.
- D. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that after curing do not deteriorate when exposed to these conditions both during and after construction.
 - 1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
 - 2. For floor penetrations with annular spaces exceeding 4 inches in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved either by installing floor plates or by other means.
 - 3. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.

- E. For through-penetration firestop systems exposed to view, provide products with flame-spread ratings of less than 25 and smoke-developed ratings of less than 450, as determined per ASTM E 84.
- F. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in "Performance Requirements" Article:
 - 1. Firestopping tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL, or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.
 - 2. Through-penetration firestop systems are identical to those tested per ASTM E 814. Provide rated systems complying with the following requirements:
 - a. Through-penetration firestop system products bear classification marking of qualified testing and inspecting agency.
 - b. Through-penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed by the following:
 - 1) UL in "Fire Resistance Directory."

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hilti Construction Chemicals, Inc.
 - 2. Specified Technologies Inc.
 - 3. 3M Fire Protection Products.
 - 4. Tremco.

2.3 FIRESTOPPING, GENERAL

- A. Compatibility: Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.

2.4 PENETRATION FIRESTOPPING

- A. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
 - 1. Fire-resistance-rated walls include fire walls, fire-barrier walls, and fire partitions.
 - 2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
- B. Penetrations in Horizontal Assemblies: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
 - 1. Horizontal assemblies include floors, floor/ceiling assemblies and ceiling membranes of roof/ceiling assemblies.
 - 2. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
 - 3. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
- C. Penetrations in Smoke Barriers: Provide penetration firestopping with ratings determined per UL 1479.
 - 1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at 0.30-inch wg at both ambient and elevated temperatures.

- D. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- E. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by the qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:
 - 1. Permanent forming/damming/backing materials, including the following:
 - a. Slag-/rock-wool-fiber insulation.
 - b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
 - c. Fire-rated form board.
 - 2. Temporary forming materials.
 - 3. Substrate primers.
 - 4. Collars.
 - 5. Steel sleeves.

2.5 MIXING

- A. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with written recommendations of firestop system manufacturer and the following requirements:
 - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.
 - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

- C. Masking Tape: Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestop system materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

3.3 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

- A. General: Install through-penetration firestop systems to comply with "Performance Requirements" Article and firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - 1. After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.
- C. Install fill materials for firestop systems by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
 - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - 3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 FIELD QUALITY CONTROL

- A. Inspecting Agency: Owner will engage a qualified independent inspecting agency to inspect through-penetration firestop systems in accordance with ASTM E 2174 and to prepare test reports.
 - 1. Inspecting agency will state in each report whether inspected through-penetration firestop systems comply with or deviate from requirements.
- B. Compliance Inspections: One week prior to inspections by authorities having jurisdiction, Manufacturer's Representative shall perform compliance inspection with General Contractor's designated representative present. Reports shall be provided to General Contractor, with a copy to the Owner, Architect, and Firestopping Installer.
- C. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued.
- D. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements.

3.5 IDENTIFICATION

- A. Penetration Identification: Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels:

1. The words: "Warning--Through-Penetration Firestop System--Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Through-penetration firestop system designation of applicable testing and inspecting agency.
4. Date of installation.
5. Through-penetration firestop system manufacturer's name.
6. Installer's name.

- B. Wall Identification: Refer to Section 099123 "Interior Painting" for identification of fire-rated walls and smoke barriers.

3.6 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce through-penetration firestop systems complying with specified requirements.

END OF SECTION 078413

SECTION 078443 - JOINT FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Joints in or between fire-resistance-rated constructions.
2. Joints at exterior curtain-wall/floor intersections.
3. Joints in smoke barriers.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: For each joint firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing agency.
1. Engineering Judgments: Where Project conditions require modification to a qualified testing agency's illustration for a particular joint firestopping system condition, submit illustration, with modifications marked, approved by joint firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each joint firestopping system, for tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

- A. Installer Certificates: From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FM Approvals according to FM Approvals 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with UL's "Qualified Firestop Contractor Program Requirements."

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install joint firestopping systems when ambient or substrate temperatures are outside limits permitted by joint firestopping system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

- B. Install and cure joint firestopping systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.8 COORDINATION

- A. Coordinate construction of joints to ensure that joint firestopping systems can be installed according to specified firestopping system design.
- B. Coordinate sizing of joints to accommodate joint firestopping systems.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics:
 - 1. Perform joint firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Test per testing standards referenced in "Joint Firestopping Systems" Article. Provide rated systems complying with the following requirements:
 - a. Joint firestopping systems shall bear classification marking of a qualified testing agency.
 - 1) UL in its "Fire Resistance Directory."
 - 2) Intertek Group in its "Directory of Listed Building Products."

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hilti Construction Chemicals, Inc.
 - 2. Specified Technologies Inc.
 - 3. 3M Fire Protection Products.
 - 4. Tremco.

2.3 JOINT FIRESTOPPING SYSTEMS

- A. Joint Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
- B. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined per ASTM E1966 or UL 2079.
 - 1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.
- C. Joints at Exterior Curtain-Wall/Floor Intersections: Provide joint firestopping systems with rating determined per ASTM E2307.
 - 1. F-Rating: Equal to or exceeding the fire-resistance rating of the floor assembly.
- D. Joints in Smoke Barriers: Provide joint firestopping systems with ratings determined per UL 2079 based on testing at a positive pressure differential of 0.30-inch wg.

1. L-Rating: Not exceeding 5.0 cfm/ft. of joint at both ambient and elevated temperatures.
- E. Head of Wall Sealing: Comply with requirements of UL HW-D-0042 or equivalent design.
 1. Contractor's Option: Spray or sealant products may be used.
 - a. 3M; FireDam Spray or FD 150+ Sealant
 - b. GCP Applied Technologies; FlameSafe 3000 Spray or FS 900 Sealant
 - c. Hilti; CP672 Firestop Spray or CP 606 Sealant
- F. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E84.
- G. Accessories: Provide components of joint firestopping systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Before installing joint firestopping systems, clean joints immediately to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:
 1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of elastomeric fill materials or compromise fire-resistive rating.
 2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with elastomeric fill materials. Remove loose particles remaining from cleaning operation.
 3. Remove laitance and form-release agents from concrete.
- B. Prime substrates where recommended in writing by joint firestopping system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION

- A. General: Install joint firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming materials and other accessories of types required to support elastomeric fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 1. After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.

- C. Install elastomeric fill materials for joint firestopping systems by proven techniques to produce the following results:
1. Elastomeric fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
 2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
 3. For elastomeric fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

- A. Joint Identification: Identify joint firestopping systems with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of joint edge so labels are visible to anyone seeking to remove or joint firestopping system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
1. The words "Warning - Joint Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
 2. Contractor's name, address, and phone number.
 3. Designation of applicable testing agency.
 4. Date of installation.
 5. Manufacturer's name.
 6. Installer's name.

3.5 FIELD QUALITY CONTROL

- A. Inspecting Agency: Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E2393.
- B. Where deficiencies are found or joint firestopping systems are damaged or removed due to testing, repair or replace joint firestopping systems so they comply with requirements.
- C. Proceed with enclosing joint firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

- A. Clean off excess elastomeric fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by joint firestopping system manufacturers and that do not damage materials in which joints occur.
- B. Provide final protection and maintain conditions during and after installation that ensure joint firestopping systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated joint firestopping systems immediately and install new materials to produce joint firestopping systems complying with specified requirements.

END OF SECTION 078443

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Silicone joint sealants.
 - 2. Nonstaining silicone joint sealants.
 - 3. Mildew-resistant joint sealants.
 - 4. Latex joint sealants.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant formulation.
 - 4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Product Test Reports: For each kind of joint sealant, for tests performed by a qualified testing agency.
- C. Preconstruction Laboratory Test Reports: From sealant manufacturer, indicating the following:
 - 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
 - 2. Interpretation of test results and written recommendations for primers and substrate preparation are needed for adhesion.
- D. Sample Warranties: For special warranties.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Product Testing: Test joint sealants using a qualified testing agency.

1. Testing Agency Qualifications: Qualified according to ASTM C1021 to conduct the testing indicated.
- C. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.6 PRECONSTRUCTION TESTING

- A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
 1. Adhesion Testing: Use ASTM C794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
 2. Compatibility Testing: Use ASTM C1087 to determine sealant compatibility when in contact with glazing and gasket materials.
 3. Submit manufacturer's recommended number of pieces of each type of material, including joint substrates, joint-sealant backings, and miscellaneous materials.
 4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 5. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures, including use of specially formulated primers.
 6. Testing will not be required if joint-sealant manufacturers submit data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, staining of, and compatibility with joint substrates and other materials matching those submitted.

1.7 FIELD CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer.
 2. When joint substrates are wet.
 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.8 WARRANTY

- A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 1. Warranty Period: Five years from date of Substantial Completion.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
 1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
 2. Disintegration of joint substrates from causes exceeding design specifications.

3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

- A. Silicone, S, P, 100/50, T, NT: Single-component, pourable, plus 100 percent and minus 50 percent movement capability traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 100/50, Uses T and NT.
 1. Products:
 - a. Dow Corning Corporation; 890-SL
 - b. Pecora Corporation; 300 SL
 - c. Sika Corporation; 728 SL
 - d. Tremco Incorporated; Spectrem 900 SL
 2. Interior Joint Locations:
 - a. Control and expansion joints in tile flooring.

2.3 NONSTAINING SILICONE JOINT SEALANTS

- A. Nonstaining Joint Sealants: No staining of substrates when tested according to ASTM C1248.
- B. Silicone, Nonstaining, S, NS, 100/50, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT. Field-tintable to match adjacent substrates.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; 790
 - b. GE Momentive SilPruf LM SCS2700
 - c. Pecora Corporation; 890
 - d. Sika Corporation; 290
 - e. Tremco Incorporated; Spectrem 1
 2. Interior Joint Locations:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Interior perimeter joints of exterior openings.

2.4 MILDEW-RESISTANT JOINT SEALANTS

- A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.

- B. Silicone, Mildew Resistant, Neutral Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; 786
 - b. Pecora Corporation; 898
 - c. Sika Corporation; SikaSil N
 - d. Tremco; Tremsil 600 White
 2. Interior Joint Locations:
 - a. Tile control and expansion joints.
 - b. Joints between plumbing fixtures and adjoining walls, floors, and counters.

2.5 LATEX JOINT SEALANTS

- A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Building Systems; Sonolac
 - b. Bostik, Inc.; Chem-Calk 600
 - c. Pecora Corporation; AC-20+
 - d. Tremco Incorporated; Tremflex 834
 2. Interior Joint Locations:
 - a. Perimeter joints between interior wall surfaces and frames of interior doors, windows and elevator entrances,
 - 1) Color: Paintable white.
 - b. Other non-dynamic interior joints including between interior wall surfaces and casework.
 - 1) Color: Clear.

2.6 JOINT-SEALANT BACKING

- A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.7 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates

and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air.
 - 3. Remove laitance and form-release agents from concrete.
 - 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
 2. Do not stretch, twist, puncture, or tear sealant backings.
 3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
1. Place sealants so they directly contact and fully wet joint substrates.
 2. Completely fill recesses in each joint configuration.
 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
1. Remove excess sealant from surfaces adjacent to joints.
 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 3. Provide concave joint profile per Figure 8A in ASTM C1193 unless otherwise indicated.
- 3.4 CLEANING
- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.
- 3.5 PROTECTION
- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 079200

SECTION 079219 - ACOUSTICAL JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes acoustical joint sealants.

1.2 ACTION SUBMITTALS

- A. Product Data: For each acoustical joint sealant.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Acoustical-Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant formulation.
 - 4. Joint-sealant color.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each kind of acoustical joint sealant, for tests performed by a qualified testing agency.
- B. Sample Warranties: For special warranties.

1.4 WARRANTY

- A. Special Installer's Warranty: Installer agrees to repair or replace acoustical joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer agrees to furnish acoustical joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Provide acoustical joint-sealant products that effectively reduce airborne sound transmission through perimeter joints and openings in building construction, as demonstrated by testing representative assemblies according to ASTM E90.

2.2 ACOUSTICAL JOINT SEALANTS

- A. Acoustical Sealant for Exposed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex acoustical sealant complying with ASTM C834.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BASF Building Systems
 - b. Hilti
 - c. Pecora Corporation
 - d. Tremco
 - 2. Colors of Exposed Acoustical Joint Sealants: As selected by Architect from manufacturer's full range of colors.
- B. Acoustical Sealant for Concealed Joints: Manufacturer's standard nonsag, nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber acoustical sealant.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BASF Building Systems
 - b. Hilti
 - c. Pecora Corporation
 - d. Tremco

2.3 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by acoustical-joint-sealant manufacturer where required for adhesion of sealant to joint substrates.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive acoustical joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing acoustical joint sealants to comply with joint-sealant manufacturer's written instructions.

- B. Joint Priming: Prime joint substrates where recommended by acoustical-joint-sealant manufacturer. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF ACOUSTICAL JOINT SEALANTS

- A. Comply with acoustical joint-sealant manufacturer's written installation instructions unless more stringent requirements apply.
- B. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical joint sealant. Install acoustical joint sealants at both faces of partitions, at perimeters, and through penetrations. Comply with ASTM C919, ASTM C1193, and manufacturer's written recommendations for closing off sound-flanking paths around or through assemblies, including sealing partitions to underside of floor slabs above acoustical ceilings.
- C. Acoustical Ceiling Areas: Apply acoustical joint sealant at perimeter edge moldings of acoustical ceiling areas in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.

3.4 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of acoustical joint sealants and of products in which joints occur.

3.5 PROTECTION

- A. Protect acoustical joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated acoustical joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 079219

SECTION 079513.13 - INTERIOR EXPANSION JOINT COVER ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes interior expansion joint cover assemblies.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for expansion joint cover assemblies.
- B. Shop Drawings: For each expansion joint cover assembly.
 - 1. Include plans, elevations, sections, details, splices, block-out requirement, attachments to other work, and line diagrams showing entire route of each expansion joint.
 - 2. Where expansion joint cover assemblies change planes, provide isometric or clearly detailed drawing depicting how components interconnect.
- C. Samples: For each expansion joint cover assembly and for each color and texture specified, full width by 6 inches long in size.
- D. Samples for Initial Selection: For each type of exposed finish.
 - 1. Include manufacturer's color charts showing the full range of colors and finishes available for each exposed metal and elastomeric-seal material.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each fire-resistance-rated expansion joint cover assembly, for tests performed by a qualified testing agency.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Furnish units in longest practicable lengths to minimize field splicing.
- B. Include factory-fabricated closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous expansion joint cover assemblies.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Expansion joint cover assemblies shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Fire-Resistance Ratings: Provide expansion joint cover assemblies with fire barriers identical to those of systems tested for fire resistance according to UL 2079 or ASTM E1966 by a qualified testing agency.

C. Expansion Joint Design Criteria:

1. Type of Movement: Seismic.
 - a. Joint Movement: 1/2" horizontal (1" nominal joint width).

2.3 FLOOR EXPANSION JOINT COVERS

A. Glide-Plate Floor Joint Cover: Assembly consisting of center plate that slides in and out of slots in metal frames fixed to sides of joint gap with cover gasket.

1. Basis of Design: C-S Group, Flush Thinline, Model GFST, 1 hour fire rated.
2. Application: Floor to Floor.
3. Installation: Flush with finish floor material.
4. Fire-Resistance Rating: Not less than one hour.
5. Exposed Metal:
 - a. Aluminum: Clear anodic, Class II.
6. Gasket: Color as selected from manufacturer's standard range.

2.4 WALL AND CEILING EXPANSION JOINT COVERS

A. Center-Plate Wall Joint Cover : Assembly consisting of center plate that slides over gaskets in metal frames fixed to sides of joint gaps.

1. Basis of Design: C-S Group, Allway Metal, Model AFW.
2. Application: Wall to Wall.
3. Fire-Resistance Rating: N/A
4. Exposed Metal:
 - a. Aluminum: Paint finish to match adjacent wall and ceiling.

2.5 MATERIALS

- A. Aluminum: ASTM B221, Alloy 6063-T5 for extrusions; ASTM B209, Alloy 6061-T6 for sheet and plate.
 1. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.
- B. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304 for plates, sheet, and strips.
- C. Elastomeric Seals: Manufacturer's standard preformed elastomeric membranes or extrusions to be installed in metal frames.
- D. Moisture Barrier: Manufacturer's standard, flexible elastomeric material.
- E. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.6 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker (floors).
- B. Prepared for paint finish (walls and ceilings).

2.7 STAINLESS-STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

2.8 ACCESSORIES

- A. Manufacturer's standard attachment devices. Include anchors, clips, fasteners, set screws, spacers, and other accessories compatible with material in contact, as indicated or required for complete installations.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces where expansion joint cover assemblies will be installed for installation tolerances and other conditions affecting performance of the Work.
- B. Notify Architect where discrepancies occur that will affect proper expansion joint cover assembly installation and performance.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to expansion joint cover assembly manufacturer's written instructions.
- B. Coordinate and furnish anchorages, setting drawings, and instructions for installing expansion joint cover assemblies. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of expansion joint cover assemblies.

3.3 INSTALLATION

- A. Comply with manufacturer's written instructions for storing, handling, and installing expansion joint cover assemblies and materials unless more stringent requirements are indicated.
- B. Metal Frames: Perform cutting, drilling, and fitting required to install expansion joint cover assemblies.
 - 1. Repair or grout block out as required for continuous frame support using nonmetallic, shrinkage-resistant grout.
 - 2. Install frames in continuous contact with adjacent surfaces.
 - a. Shimming is not permitted.
 - 3. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
 - 4. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation.
 - 5. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
 - 6. Locate anchors at interval recommended by manufacturer, but not less than 3 inches from each end and not more than 24 inches o.c.

- C. Seals: Install elastomeric seals and membranes in frames to comply with manufacturer's written instructions. Install with minimum number of end joints.
 - 1. Provide in continuous lengths for straight sections.
 - 2. Seal transitions. Vulcanize or heat-weld field-spliced joints as recommended by manufacturer.
 - 3. Installation: Mechanically lock seals into frames or adhere to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.
- D. Install with hairline mitered corners where expansion joint cover assemblies change direction or abut other materials.
- E. Terminate exposed ends of expansion joint cover assemblies with field- or factory-fabricated termination devices.
- F. Fire-Resistance-Rated Assemblies: Coordinate installation of expansion joint cover assembly materials and associated work so complete assemblies comply with performance requirements.
 - 1. Fire Barriers: Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and field splices.

3.4 PROTECTION

- A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.
- B. Protect the installation from damage by work of other Sections. Where necessary due to heavy construction traffic, remove and properly store cover plates or seals and install temporary protection over expansion joint cover assemblies. Reinstall cover plates or seals prior to Substantial Completion.

END OF SECTION 079513.13

SECTION 079513.16 - EXTERIOR EXPANSION JOINT COVER ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior expansion joint covers.

B. Related Requirements:

1. Section 077129 "Manufactured Roof Expansion Joints" for factory-fabricated roof expansion joint cover assemblies.
2. Section 079100 "Preformed Joint Seals" for preformed foam and extruded-silicone joint seals.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for expansion joint cover assemblies.

B. Shop Drawings: For each expansion joint cover assembly.

1. Include plans, elevations, sections, details, splices, block-out requirement, attachments to other work, and line diagrams showing entire route of each expansion joint.
2. Where expansion joint cover assemblies change planes, provide isometric or clearly detailed drawing depicting how components interconnect.

C. Samples: For each exposed expansion joint cover assembly and for each color and texture specified, full width by 6 inches long in size.

D. Samples for Initial Selection: For each type of exposed finish.

1. Include manufacturer's color charts showing the full range of colors and finishes available for each exposed metal and elastomeric seal material.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Furnish units in longest practicable lengths to minimize field splicing.

B. Include factory-fabricated closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous expansion joint cover assemblies.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Expansion joint cover assemblies shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

B. Expansion Joint Design Criteria:

1. Type of Movement: Thermal.
 - a. Nominal Joint Width: 1 inch.
2. Seismic Movement:
 - a. Joint Movement: 1/2 inch in-plane (1-inch nominal joint width).

2.3 EXTERIOR EXPANSION JOINT COVERS

- A. Preformed Foam Joint Seals: Manufacturer's standard joint seal manufactured from urethane or EVA (ethylene vinyl acetate) foam with minimum density of 10 lb/cu. ft. and impregnated with a nondrying, water-repellent agent. Factory produce in precompressed sizes in roll or stick form to fit joint widths based on design criteria indicated, with factory- or field-applied adhesive for bonding to substrates.
 1. Basis of Design: C-S Group, VF Series.
 2. Design Criteria:
 - a. Nominal Joint Width: 1 inch.
 - b. Movement Capability: -25 percent/+25 percent.
 3. Joint Seal Color: As selected by Architect from manufacturer's full range.

2.4 MATERIALS

- A. Moisture Barrier: Manufacturer's standard, flexible elastomeric material.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces where expansion joint cover assemblies will be installed for installation tolerances and other conditions affecting performance of the Work.
- B. Notify Architect where discrepancies occur that will affect proper expansion joint cover assembly installation and performance.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to expansion joint cover assembly manufacturer's written instructions.
- B. Coordinate and furnish anchorages, setting drawings, and instructions for installing expansion joint cover assemblies. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of expansion joint cover assemblies.

3.3 INSTALLATION

- A. Comply with manufacturer's written instructions for storing, handling, and installing expansion joint cover assemblies and materials unless more stringent requirements are indicated.
- B. Preformed Foam Joint Seals: Install in compliance with manufacturer's written instructions. Install with minimum number of end joints.

1. Install each length of seal immediately after removing protective wrapping.
 2. Firmly secure compressed joint seals to joint gap side to obtain full bond using exposed pressure-sensitive adhesive or field-applied adhesive as recommended by manufacturer.
 3. Do not pull or stretch material. Produce seal continuity at splices, ends, turns, and intersections of joints.
 4. For applications at low ambient temperatures, heat foam joint seal material in compliance with manufacturer's written instructions.
- C. Install with hairline mitered corners where expansion joint cover assemblies change direction or abut other materials.
- D. Terminate exposed ends of expansion joint cover assemblies with field- or factory-fabricated termination devices.

3.4 CONNECTIONS

- A. Transition to Roof Expansion Joint Covers: Coordinate installation of exterior wall and soffit expansion joint covers with roof expansion joint covers specified in Section 077129 "Manufactured Roof Expansion Joints." Install factory-fabricated units at transition between exterior walls and soffits and roof expansion joint cover assemblies.

3.5 PROTECTION

- A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.
- B. Protect the installation from damage by work of other Sections.

END OF SECTION 079513.16

SECTION 081213 - HOLLOW METAL FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Interior standard steel frames.
 - 2. Borrowed lites.

1.2 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.3 COORDINATION

- A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.
- B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, fire-resistance ratings, and finishes.
- B. Shop Drawings: Include the following:
 - 1. Elevations of each frame type.
 - 2. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 - 3. Locations of reinforcement and preparations for hardware.
 - 4. Details of each different wall opening condition.
 - 5. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
 - 6. Details of anchorages, joints, field splices, and connections.
 - 7. Details of accessories.
 - 8. Details of moldings, removable stops, and glazing.
- C. Product Schedule: For hollow-metal frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.6 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each type of fire-rated hollow-metal frame assembly for tests performed by a qualified testing agency indicating compliance with performance requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
 - 1. Provide additional protection to prevent damage to factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow-metal frames vertically under cover at Project site with head up. Place on minimum 4-inch-high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Amweld Building Products, LLC
 - 2. Ceco Door Products; an Assa Abloy Group company
 - 3. Curries Company; an Assa Abloy Group company
 - 4. Pioneer Industries, Inc.
 - 5. Premier Products, Inc.
 - 6. Republic Doors and Frames
 - 7. Steelcraft; an Ingersoll-Rand company

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated on Drawings, based on testing at positive pressure according to NFPA 252 or UL 10C.
 - 1. Smoke- and Draft-Control Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

2.3 STANDARD STEEL FRAMES

- A. Construct hollow-metal frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Interior Frames: SDI A250.8. At locations indicated in the Door and Frame Schedule.
 - 1. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch.
 - a. Provide A60 galvanized coating at wet locations.
 - 2. Sidelite Frames: Fabricated from same thickness material as adjacent door frame.

3. Construction: Full profile welded.
4. Exposed Finish: Prime.

2.4 BORROWED LITES

- A. Fabricate of uncoated steel sheet, minimum thickness of 0.053 inch.
- B. Construction: Full profile welded.
- C. Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as metal as frames.
- D. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

2.5 FRAME ANCHORS

- A. Jamb Anchors:
 1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
 2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches of frame height above 7 feet.
 3. Postinstalled Expansion Anchor: Minimum 3/8-inch- diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.
- B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.
- C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at top of underlayment.
- D. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.
 1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized according to ASTM A153/A153M, Class B.

2.6 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B with minimum A60 (galvannealed) metallic coating.
- D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A153/A153M.
- E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

- F. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6- to 12-lb/cu. ft. density; with maximum flame-spread and smoke-development indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
- G. Glazing: Comply with requirements in Section 088000 "Glazing."

2.7 FABRICATION

- A. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
 - 1. Sidelite Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding.
 - 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - 3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
 - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
- B. Hardware Preparation: Factory prepare hollow-metal frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.
 - 1. Reinforce frames to receive nontemplated, mortised, and surface-mounted door hardware.
 - 2. Comply with BHMA A156.115 for preparing hollow-metal frames for hardware.
- C. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
 - 1. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
 - 2. Provide fixed frame moldings on outside of exterior and on secure side of interior frames. Provide loose stops and moldings on inside of hollow-metal frames.
 - 3. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
 - 4. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

2.8 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
 - 1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.
- B. Drill and tap frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

- A. General: Install hollow-metal frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions. Comply with SDI A250.11.
- B. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
 - 1. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
 - 2. Install frames with removable stops located on secure side of opening.
- C. Fire-Rated Openings: Install frames according to NFPA 80.
- D. Floor Anchors: Secure with postinstalled expansion anchors.
 - 1. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
- E. Solidly pack mineral-fiber insulation inside frames.
- F. In-Place Concrete Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
- G. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
 - 1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - 2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - 3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - 4. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
- H. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.

3.3 CLEANING AND TOUCHUP

- A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

- B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.
- C. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 081213

SECTION 081216 - ALUMINUM FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior aluminum door frames and glazing frames.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For aluminum frames:

1. Include elevations, sections, and installation details for each wall-opening condition.
2. Include details for each frame type, including dimensioned profiles and metal thicknesses.
3. Include locations of reinforcements and preparations for hardware.
4. Include details of anchorages, joints, field splices, connections, and accessories.
5. Include details of moldings, removable stops, and glazing.

C. Samples: For each exposed product and for each color and texture specified, in manufacturer's standard sizes.

D. Product Schedule: For aluminum frames. Use same designations indicated on Drawings. Coordinate with door hardware schedule and glazing.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For aluminum frames to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for fabrication and installation.

1. Build mockup of each type of aluminum frame in typical wall area as shown on Drawings.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Frameworks, Inc.; an ASSA ABLOY Group company.
 - 2. Modulex Products, Inc.
 - 3. RACO Interior Products, Inc.
 - 4. Versatrac Frames; a division of American Door Products Inc.
 - 5. Wilson Partitions; a division of Acradia, Inc.
- B. Source Limitations: Obtain aluminum frames from single source from single manufacturer.

2.2 INTERIOR ALUMINUM DOOR FRAMES AND GLAZING FRAMES

- A. Aluminum Framing: ASTM B221, with alloy and temper required to suit structural and finish requirements, and not less than 0.062 inch thick.
- B. Door Frames: Extruded aluminum, reinforced for hinges, strikes, and closers.
- C. Glazing Frames: Extruded aluminum, for indicated glass thickness.
- D. Trim: Extruded aluminum, not less than 0.062 inch thick; removable, snap-in glazing stops and door stops, without exposed fasteners.
- E. Doors: As specified in Section 081416 "Flush Wood Doors."
- F. Frame and Trim Finish: Color-anodized aluminum.
 - 1. Color: Dark bronze.

2.3 ACCESSORIES

- A. Fasteners: Aluminum, nonmagnetic, stainless steel or other noncorrosive metal fasteners compatible with frames, stops, panels, reinforcement plates, hardware, anchors, and other items being fastened.
- B. Door Silencers: Manufacturer's standard continuous mohair, wool pile, or vinyl seals in black color.
- C. Glazing Gaskets: Manufacturer's standard extruded or molded rubber or plastic, to accommodate glazing thickness indicated; in black.
- D. Glass: As specified in Section 088000 "Glazing."
- E. Door Hardware: As specified in Section 087100 "Door Hardware."

2.4 FABRICATION

- A. Provide concealed corner reinforcements and alignment clips for accurately fitted hairline joints at butted and mitered connections.

- B. Factory prepare aluminum frames to receive templated mortised hardware; include cutouts, reinforcements, mortising, drilling, and tapping, according to the Door Hardware Schedule and templates furnished as specified in Section 087100 "Door Hardware."
- C. Fabricate frames for glazing with removable stops to allow glazing replacement without dismantling frame.
 - 1. Locate removable stops on the inside of spaces accessed by keyed doors.
- D. Fabricate components to allow secure installation without exposed fasteners.

2.5 GENERAL FINISH REQUIREMENTS

- A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.6 ALUMINUM FINISHES

- A. Color Anodic Finish: AAMA 611, AA-M12C22A32/A34, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify that wall thickness does not exceed standard tolerances allowed by throat size of indicated aluminum frame.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install aluminum frames plumb, rigid, properly aligned, and securely fastened in place; according to manufacturer's written instructions.
- B. Install frame components in the longest possible lengths with no piece less than 48 inches; components 96 inches or shorter shall be one piece.
 - 1. Use concealed installation clips to produce tightly fitted and aligned splices and connections.
 - 2. Secure clips to extruded main-frame components and not to snap-in or trim members.
 - 3. Do not leave screws or other fasteners exposed to view when installation is complete.
- C. Glass: Install glass according to Section 088000 "Glazing" and aluminum-frame manufacturer's written instructions.
- D. Doors: Install doors aligned with frames and fitted with required hardware.
- E. Door Hardware: Install according to Section 087100 "Door Hardware" and aluminum-frame manufacturer's written instructions.

3.3 ADJUSTING

- A. Inspect installation, correct misalignments, and tighten loose connections.
- B. Doors: Adjust doors to operate smoothly and easily, without binding or warping. Adjust hardware to function smoothly, and lubricate as recommended by manufacturer.
- C. Clean exposed frame surfaces promptly after installation, using cleaning methods recommended in writing by frame manufacturer and according to AAMA 609 & 610.
- D. Touch Up: Repair marred frame surfaces to blend inconspicuously with adjacent unrepaired surface so touchup is not visible from a distance of 48 inches as viewed by Architect. Remove and replace frames with damaged finish that cannot be satisfactorily repaired.

END OF SECTION 081216

SECTION 081416 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Five-ply flush wood veneer-faced doors for transparent finish.
2. Factory finishing flush wood doors.
3. Factory fitting flush wood doors to frames and factory machining for hardware.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:

1. Door core materials and construction.
2. Door edge construction
3. Door face type and characteristics.
4. Door trim for openings.
5. Factory-machining criteria.
6. Factory- finishing specifications.

B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each type of door; construction details not covered in Product Data; and the following:

1. Door schedule indicating door location, type, size, fire protection rating, and swing.
2. Door elevations, dimension and locations of hardware, lite cutouts, and glazing thicknesses.
3. Details of frame for each frame type, including dimensions and profile.
4. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
5. Dimensions and locations of blocking for hardware attachment.
6. Dimensions and locations of mortises and holes for hardware.
7. Clearances and undercuts.
8. Requirements for veneer matching.
9. Doors to be factory finished and application requirements.

C. Samples: For factory-finished doors.

1.3 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Special warranties.

1.5 QUALITY ASSURANCE

A. Manufacturer's Certification: Licensed participant in AWT's Quality Certification Program.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until building is enclosed and weathertight, wet work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 43 and 70 percent during remainder of construction period.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Delamination of veneer.
 - b. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
 - c. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
 - 2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
 - 3. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Lambton Doors
 - 2. Masonite Architectural
 - 3. Oshkosh Door Company
 - 4. VT Industries, Inc./Eggers Industries
- B. Source Limitations: Obtain flush wood doors from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Wood Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated on Drawings, based on testing at positive pressure in accordance with NFPA 252.
- B. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.

2.3 FLUSH WOOD DOORS, GENERAL

- A. Quality Standard: In addition to requirements specified, comply with AWI/AWMAC/WT's "Architectural Woodwork Standards."

1. The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with the Contract Documents in addition to those of the referenced quality standard.

2.4 SOLID-CORE FIVE-PLY FLUSH WOOD VENEER-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Doors:

1. Performance Grade: ANSI/WDMA I.S. 1A Heavy Duty.
2. Architectural Woodwork Standards Grade: Custom.
3. Faces: Single-ply wood veneer not less than 1/50 inch thick.
 - a. Species: Select white maple.
 - b. Cut: Plain sliced (flat sliced).
 - c. Match between Veneer Leaves: Slip match.
 - d. Assembly of Veneer Leaves on Door Faces: Center-balance match.
 - e. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
 - f. Room Match: Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by 10 feet or more.
4. Exposed Vertical and Top Edges: Same species as faces - Architectural Woodwork Standards edge Type A.
 - a. Fire-Rated Single Doors: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed vertical edges.
 - b. Fire-Rated Pairs of Doors: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
 - c. Mineral-Core Doors: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
 - 1) Screw-Holding Capability: 475 lbf in accordance with WDMA T.M. 10.
5. Core for Non-Fire-Rated Doors:
 - a. ANSI A208.1, Grade LD-2 particleboard.
 - 1) Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware.
 - a) 5-inch top-rail blocking, in doors indicated to have closers.
 - b) 5-inch bottom-rail blocking, in doors indicated to have kick, mop, or armor plates.
 - c) 5-inch midrail blocking, in doors indicated to have exit devices.
 - 2) Provide doors with WDMA I.S. 10 structural-composite-lumber cores instead of particleboard cores for doors scheduled to receive exit devices in Section 087100 "Door Hardware."
6. Core for Fire-Rated Doors: As required to achieve fire-protection rating indicated on Drawings.
 - a. Blocking for Mineral-Core Doors: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated on Drawings as needed to eliminate through-bolting hardware.
 - 1) 5-inch top-rail blocking.
 - 2) 5-inch bottom-rail blocking, in doors indicated to have protection plates.
 - 3) 5-inch midrail blocking, in doors indicated to have armor plates.
 - 4) 5-inch midrail blocking, in doors indicated to have exit devices.

7. Construction: Five plies, hot-pressed bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before veneering.

2.5 LIGHT FRAMES

- A. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads unless otherwise indicated.
 1. Wood Species: Species compatible with door faces.
 2. Profile: Manufacturer's standard shape.
 3. At wood-core doors with 20-minute fire-protection ratings, provide wood beads and metal glazing clips approved for such use.
- B. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer's standard frame formed of 0.048-inch- thick, cold-rolled steel sheet; with baked-enamel- or powder-coated finish; and approved for use in doors of fire-protection rating indicated on Drawings.

2.6 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated.
 1. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
 2. Comply with NFPA 80 requirements for fire-rated doors.
- B. Factory machine doors for hardware that is not surface applied.
 1. Locate hardware to comply with DHI-WDHS-3.
 2. Comply with final hardware schedules, door frame Shop Drawings, ANSI/BHMA-156.115-W, and hardware templates.
 3. Coordinate with hardware mortises in metal frames, to verify dimensions and alignment before factory machining.
 4. For doors scheduled to receive electrified locksets, provide factory-installed raceway and wiring to accommodate specified hardware.
 5. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.
- C. Openings: Factory cut and trim openings through doors.
 1. Light Openings: Trim openings with moldings of material and profile indicated.
 2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 088000 "Glazing."

2.7 FACTORY FINISHING

- A. Comply with referenced quality standard for factory finishing.
 1. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
 2. Finish faces, all four edges, edges of cutouts, and mortises.
 3. Stains and fillers may be omitted on bottom edges, edges of cutouts, and mortises.
- B. Factory finish doors.
- C. Transparent Finish:

1. Architectural Woodwork Standards Grade: Custom.
2. Finish: Architectural Woodwork Standards System-5, Varnish, Conversion or Architectural Woodwork Standards System-11, Polyurethane, Catalyzed.
3. Staining: As selected by Architect from manufacturer's full range.
4. Effect: Filled finish.
5. Sheen: Satin.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and installed door frames, with Installer present, before hanging doors.
 1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
 2. Reject doors with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Hardware: For installation, see Section 087100 "Door Hardware."
- B. Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
- C. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
- D. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 ADJUSTING

- A. Operation: Rehang or replace doors that do not swing or operate freely.
- B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 081416

SECTION 083113 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Access doors and frames.
 - 2. Fire-rated access doors and frames.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, fire ratings, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Product Schedule: For access doors and frames.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing and inspecting agency.
 - 1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
 - 2. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.

1.4 CLOSEOUT SUBMITTALS

- A. Record Documents: For fire-rated doors, list of applicable room name and number in which access door is located.

1.5 QUALITY ASSURANCE

- A. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies shall meet the qualifications set forth in NFPA 80, Section 5.2.3.1 and the following:
 - 1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Access Doors and Frames: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, according to NFPA 252 or UL 10B.

2.2 ACCESS DOORS AND FRAMES

- A. Flush Access Doors with Concealed Flanges:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Activar Construction Products Group, Inc. - JL Industries.
 - b. ACUDOR Products, Inc.
 - c. Babcock-Davis.
 - d. Karp Associates, Inc.
 - e. Larsens Manufacturing Company.
 - f. MIFAB, Inc.
 - g. Milcor; a division of Hart & Cooley, Inc.
 - h. Nystrom.
 - i. Williams Bros. Corporation of America (The).
2. Description: Face of door flush with frame; with concealed flange for gypsum board installation and concealed hinge.
 3. Optional Features: Piano hinges.
 4. Locations: Wall and ceiling.
 5. Door Size: As indicated on Drawings or as required for access.
 6. Uncoated Steel Sheet for Door: Nominal 0.060 inch, 16 gage, factory primed.
 7. Metallic-Coated Steel Sheet for Door in Wet Areas: Nominal 0.064 inch, 16 gage factory primed.
 8. Frame Material: Same material and thickness as door.
 9. Latch and Lock: Cam latch, screwdriver operated.

2.3 FIRE-RATED ACCESS DOORS AND FRAMES

A. Fire-Rated, Flush Access Doors with Concealed Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Activar Construction Products Group, Inc. - JL Industries.
 - b. ACUDOR Products, Inc.
 - c. Babcock-Davis.
 - d. Karp Associates, Inc.
 - e. Larsens Manufacturing Company.
 - f. MIFAB, Inc.
 - g. Milcor; a division of Hart & Cooley, Inc.
 - h. Nystrom.
 - i. Williams Bros. Corporation of America (The).
2. Description: Door face flush with frame, with a core of mineral-fiber insulation enclosed in sheet metal; with concealed flange for gypsum board installation, self-closing door, and concealed hinge.
3. Optional Features: Upward-opening doors for ceilings and piano hinges.
4. Locations: Wall and ceiling.
5. Door Size: As indicated on Drawings or as required for access.
6. Fire-Resistance Rating: Not less than that of adjacent construction.
7. Uncoated Steel Sheet for Door: Nominal 0.036 inch, 20 gage, factory primed.
8. Metallic-Coated Steel Sheet for Door in Wet Areas: Nominal 0.040 inch, 20 gage, factory primed.
9. Frame Material: Same material, thickness, and finish as door.
10. Latch and Lock: Self-closing, self-latching door hardware, operated by key.

2.4 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A879/A879M, with cold-rolled steel sheet substrate complying with ASTM A1008/A1008M, Commercial Steel (CS), exposed.

- C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with minimum G60 or A60 metallic coating.
- D. Frame Anchors: Same material as door face.
- E. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329.

2.5 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.
 - 1. For concealed flanges with drywall bead, provide edge trim for gypsum panels securely attached to perimeter of frames.
- D. Latch and Lock Hardware:
 - 1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.
 - 2. Keys: Furnish two keys per lock and key all locks alike.
 - 3. Mortise Cylinder Preparation: Where indicated, prepare door panel to accept cylinder specified in Section 087100 "Door Hardware."

2.6 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 - 1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.

3.3 FIELD QUALITY CONTROL

- A. Inspection Agency: Owner will engage a qualified inspector to perform inspections and to furnish reports to Architect.
- B. Fire-Rated Door Inspections: Inspect each fire-rated access door in accordance with NFPA 80, Section 5.2.
- C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.
- E. Prepare and submit separate inspection report for each fire-rated access door indicating compliance with each item listed in NFPA 80 and NFPA 101.

3.4 ADJUSTING

- A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION 083113

SECTION 084126.23 - INTERIOR ALL-GLASS ENTRANCES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Interior, manual-sliding, all-glass entrance systems.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for all-glass system.
- B. Shop Drawings: For interior all-glass entrance systems.
 - 1. Include plans, elevations, and sections.
 - 2. Include details of fittings, sliding door carrier assemblies and tracks, and glazing, including isometric drawings of fittings.
 - 3. Include door hardware locations, mounting heights, and installation requirements.
- C. Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate final door hardware schedule with door components, assemblies, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For interior all-glass entrance systems to include in maintenance manuals. Furnish a complete set of specialized tools and maintenance instructions as required for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer for installation of units required for this Project.
- B. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions,

arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.7 MOCKUPS

- A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 1. Build mockup for interior all-glass door including accessories.
 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of interior all-glass entrance systems that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - b. Failure of operating components.
 2. Warranty Period: Two years from date of Substantial Completion for assembly and components unless otherwise indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain all components of interior all-glass entrance systems, including accessories, from single manufacturer.

2.2 INTERIOR, MANUAL-SLIDING, ALL-GLASS ENTRANCE SYSTEMS

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
 1. Avanti Systems, Inc.
 2. Oldcastle BuildingEnvelope
 3. Virginia Glass Products
- B. Door Fitting Configuration: Continuous rail fitting at top and bottom (P-Style).
- C. Fitting Material: Aluminum.
- D. Rail Fittings:
 1. Height:
 - a. Top Rail: 3-1/2 inches.
 - b. Bottom Rail: 3-1/2 inches.

2. Profile: Tapered.
 3. End Caps: Manufacturer's standard precision-fit end caps for rail fittings.
- E. Accessory Fittings: U-channel.
- F. Anchors and Fastenings: Concealed.
- G. Door Hardware: In sizes, quantities, and types recommended by manufacturer for interior all-glass entrance systems indicated.
1. Opening-Force Requirements:
 - a. Egress Doors: Not more than 30 lbf to set the door in motion and not more than 15 lbf to close the door or open it to its minimum required width.
 - b. Accessible Interior Sliding Doors: Not more than 5 lbf to fully open door.
 2. Door Pulls: As selected from manufacturer's full range.
 3. Active Glass Panel Locksets: Bottom-fitting or bottom-rail deadbolt.
 4. Deadbolt operated by key outside and thumbturn inside.
 5. Cylinders: As specified in Section 087100 "Door Hardware."
 6. Sliding Door Carrier Assemblies and Tracks:
 - a. General: Provide manufacturer's framing, headers, carrier assemblies, tracks, and accessories required for a complete installation.
 - b. Top-Hung System: Overhead track assembly for supporting glass panels hung from roller assembly.
 - 1) Overhead Track:
 - a) Mount: Wall and aluminum frame system.
 - b) Size: As indicated on Drawings.
 - c) Material: Aluminum.
 - 2) Rollers: Adjustable, heavy-duty ball bearing rollers (two per panel).
 - 3) Break Metal Cover: Aluminum.
 - 4) Floor Support:
 - a) Mount: Floor guide.
 - b) Size: As indicated on Drawings.
 - c) Material: Match overhead track.
 - 5) Accessory Components: Door stops, roller, and track/guide mounts.

2.3 GLASS

- A. Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated surfaces), Type I (transparent), Quality-Q3, tested for surface and edge compression in accordance with ASTM C1048 and for impact strength in accordance with 16 CFR 1201 for Category II materials.
1. Class 1: Clear monolithic.
 - a. Thickness: 12 mm.
 2. Exposed Edges: Machine ground and flat polished.

2.4 MATERIALS

- A. Aluminum: ASTM B221 with strength and durability characteristics of not less than Alloy 6063-T5 for extruded bars, rods, profiles, and tubes. ASTM B209 for sheet and plate.

1. Color Anodic Finish: AAMA 611, AA-M12C22A32/A34, Class II, 0.010 mm or thicker.
 - a. Color: Dark bronze.

- B. Structural Shapes, Plates, and Bars: ASTM A36/A36M.

2.5 FABRICATION

- A. Provide holes and cutouts in glass to receive hardware, fittings, and accessory fittings before tempering glass. Do not cut, drill, or make other alterations to glass after tempering.
 1. Fully temper glass using horizontal (roller-hearth) process, and fabricate so that when glass is installed, roll-wave distortion is parallel with bottom edge of door or lite.
- B. Factory assemble components and factory install hardware and fittings to greatest extent possible.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Install all-glass entrance systems and associated components in accordance with manufacturer's written instructions.
- B. Set units level, plumb, and true to line, with uniform joints.
- C. Maintain uniform clearances between adjacent components.
- D. Lubricate hardware and other moving parts in accordance with manufacturer's written instructions.
- E. Set, seal, and grout floor closer cases as required to suit hardware and substrate indicated.

3.3 ADJUSTING AND CLEANING

- A. Adjust all-glass doors and hardware to produce smooth operation and tight fit at contact points.
 1. For all-glass, swinging entrance doors accessible to people with disabilities, adjust closers to provide a three-second closer sweep period for doors to move from a 70-degree open position to 3 inches from the latch measured to the leading door edge.
- B. Remove excess sealant and glazing compounds and dirt from surfaces.

END OF SECTION 084126.23

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Commercial door hardware for the following:
 - a. Swinging doors.
 - b. Sliding doors.
 - c. Other doors to the extent indicated.
 2. Special Requirements:
 - a. Hardware Installation: The General Contractor shall not install door hardware. The Door Hardware Distributor/Supplier shall be responsible for the proper installation of the door hardware supplied to this project. If supplier has staff trained and performing installations (service available) the supplier shall install the hardware with its own forces. If the door hardware supplier does not have installation capabilities then it shall contract with an experienced hardware installation firm to install door hardware for this project. The hardware supplier shall be financially responsible for damages and correction costs involved with improperly installed door hardware.
 - 1) Experience requirements for the Door Hardware Installer: 3 years of door hardware installation and completion of 2 projects of similar size, scope, and complexity within the past year.
- B. Products furnished, but not installed, under this Section include the following. Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.
1. Hardware specified for other Sections.

1.2 ACTION SUBMITTALS

- A. Product Data: Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Samples for Verification: For exposed door hardware of each type, in specified finish, full size. Tag with full description for coordination with the door hardware sets. Submit Samples before, or concurrent with, submission of the final door hardware sets.
1. Samples will be returned to Contractor. Units that are acceptable and remain undamaged through submittal, review, and field comparison process may, after final check of operation, be incorporated into the Work, within limitations of keying requirements.
- C. Door Hardware Sets: Prepared by or under the supervision of Architectural Hardware Consultant and sealed by the consultant, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final door hardware sets with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
1. Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.
 2. Content: Include the following information:
 - a. Identification number, location, hand, fire rating, and material of each door and frame.

- b. Type, style, function, size, quantity, and finish of each door hardware item. Include description and function of each lockset and exit device.
 - c. Complete designations of every item required for each door or opening including name and manufacturer.
 - d. Fastenings and other pertinent information.
 - e. Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - f. Explanation of abbreviations, symbols, and codes contained in schedule.
 - g. Mounting locations for door hardware.
 - h. Door and frame sizes and materials.
 - i. List of related door devices specified in other Sections for each door and frame.
 - 3. Submittal Sequence: Submit initial draft of final schedule along with essential Product Data to facilitate the fabrication of other work that is critical in Project construction schedule. Submit the final door hardware sets after Samples, Product Data, coordination with Shop Drawings of other work, delivery schedules, and similar information has been completed and accepted.
 - 4. Do not proceed with ordering components, preparing doors and frames, or installation until the final Door Hardware Schedule is approved by the Architect.
- D. Keying Schedule: Prepared by or under the supervision of Architectural Hardware Consultant, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Warranty: Special warranty specified in this Section.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware and keying schedule.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by lock manufacturer.
 - 1. Installer's responsibilities include supplying and installing door hardware and providing a qualified Architectural Hardware Consultant available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.
 - 2. Installer shall have warehousing facilities in Project's vicinity.
 - 3. Scheduling Responsibility: Preparation of door hardware and keying schedules.
- B. Architectural Hardware Consultant Qualifications: A person who is currently certified by DHI as an Architectural Hardware Consultant and is currently a DHI seal member, and who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.
 - 1. Will make site visits as necessary to ensure proper installation of door hardware.
 - 2. Will prepare door hardware and keying schedules.
- C. Source Limitations: Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.

- D. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL 10C.
1. Test Pressure: After 5 minutes into the test, neutral pressure level in furnace shall be established at 40 inches or less above the sill.
- E. Means of Egress Doors (NFPA 101):
1. Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.
 2. Door Closers: Not more than 30 lbf to set door in motion and not more than 15 lbf to open door to minimum required width.
- F. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the State Building Code, current edition, U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1, including but not limited to the following:
1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.
 2. Comply with the following maximum opening-force requirements:
 - a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf applied perpendicular to door.
 - b. Sliding or Folding Doors: 5 lbf applied parallel to door at latch.
 - c. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
 - d. Exterior Doors: 8-1/2 lbf, applied perpendicular to door.
 3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch high (NFPA 101).
 4. Adjust door closer sweep periods as indicated in Part 3 of this Section.
- G. Keying Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." In addition to Owner, Contractor, and Architect, conference participants shall also include Installer's Architectural Hardware Consultant. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:
1. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
 2. Preliminary key system schematic diagram.
 3. Requirements for key control system.
 4. Address for delivery of keys.
- H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to door hardware including, but not limited to, the following:
1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 2. Review required testing, inspecting, and certifying procedures.

1.6 COORDINATION

- A. Templates: Distribute door hardware templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

- B. Coordinate door pulls with cylinder lock location to confirm pulls do not interfere with access to lock. Provide offset pulls if required.
- C. Existing Openings: Where new hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide for proper operation.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fails in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including excessive deflection, cracking, or breakage.
 - b. Faulty operation of operators and door hardware.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
 - 2. Warranty Period: Three years from date of Substantial Completion, except as follows:
 - a. Exit Devices: Two years from date of Substantial Completion.
 - b. Manual Closers: 10 years from date of Substantial Completion.
 - c. Locks and Latches: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. Provide door hardware as indicated in Door Hardware Schedule at the end of this Section.

2.2 KEY LOCK BOX

- A. Key Lock Box: Designed for storage of two keys, with tamper switches to connect to intrusion detection system.
 - 1. Manufacturers:
 - a. ABLOY Security, Inc.; an ASSA ABLOY Group company
 - b. Knox Company
 - c. Supra Products
 - 2. Mounting: Recessed.
 - 3. Finish: Powder coating.
 - a. Color: As selected by Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Steel Doors and Frames: Comply with DHI A115 Series.
 - 1. Surface-Applied Door Hardware: Drill and tap doors and frames according to ANSI A250.6.
- B. Wood Doors: Comply with DHI A115-W Series.

3.3 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights indicated on Drawings and as follows unless otherwise indicated or required to comply with governing regulations.
 - 1. Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
 - 3. Exit devices to be mounted at 37 inches AFF.
- B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 09 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
 - 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 - 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- C. Key Lock Box:
 - 1. Coordinate location with local fire department and authorities having jurisdiction. Coordinate with AHJ for quantity, locations, and mounting heights.
 - 2. Install in accordance with manufacturer's written installation instructions.
- D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Section 079200 "Joint Sealants."

3.4 FIELD QUALITY CONTROL

- A. Independent Architectural Hardware Consultant: Owner may engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.
 - 1. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended.

Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Door Closers: Unless otherwise required by authorities having jurisdiction, adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the leading edge of the door.

3.6 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 087100

Manufacturer List

200913 : NHC GOVERNMENT CENTER FITUPS

<u>Code</u>	<u>Name</u>
BE	Best Access Systems
HA	Hager
HS	HES
NA	National Guard
PR	Precision
ST	Stanley
TR	Trimco
VA01	SECURITY DOOR CONTROLS

Hardware Sets

200913 : NHC GOVERNMENT CENTER FITUPS

SET #01

Doors: 121, 122B, 123B, 124, 125, 126B, 147B, 155, 157, 158, 161, 163A, 167, 171A, 176, 177, 178

3 Hinges	FBB179 4 1/2 X 4 1/2	US26D	ST
1 Lockset	45H-7D15H PATD CORMAX PATENTED KEYING	626	BE
1 Electric Strike	1500C	630	HS
1 Closer	HD7016 AO8P	689	BE
1 Wall Bumper	1270CX	626	TR
3 Door Silencer	307D	GREY	HA

NOTE: BALANCE OF ACCESS CONTROL BY OTHERS

SET #02

Doors: 122A, 164, 165, 166, 168, 169, 170, 173, 174, 223, 224, 225, 226, 228, 229, 230, 231, 239, 240, 241, 242, 243, 244, 246, 248, 249, 250, 251, 253, 254, 255, 256, 257, 258, 260, 261, 262, 263, 264, 323, 324, 325, 326, 328, 329, 330, 331, 338, 339, 340, 341, 342, 344, 345, 346, 347, 348, 351, 352, 353, 354, 355, 357, 358, 360, 363, 364, 365, 368, 370, 371, 372, 373, 374, 376, 377, 378, 379, 381, 382, 383, 384, 385, 386, 387, 388, 389, 423, 425, 427, 428, 429, 430, 431, 438A, 438B, 438E, 438F, 438G, 438H, 438I, 438J, 440, 441, 442, 443, 444, 447, 448, 449, 450, 451, 456, 457, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 475, 476, 477, 478, 479, 480, 482, 483, 484, 485, 486, 488, 489, 490, 491, 492, 493, 494, 495, 496, 498, 499

3 Hinges	FBB179 4 1/2 X 4 1/2	US26D	ST
1 Lockset	45H-7AB15H PATD CORMAX PATENTED KEYING	626	BE
1 Wall Bumper	1270CX	626	TR
3 Door Silencer	307D	GREY	HA

SET #03

Doors: 123A, 126A, 140, 142, 143, 175, 222A, 222B, 227, 232, 271, 278, 279B, 282, 285, 286, 322A, 322B, 332, 335, 343A, 343B, 349, 356A, 356B, 362, 369A, 369B, 375A, 375B, 422A, 422B, 424A, 424B, 438K, 438L, 445, 453A

3 Hinges	FBB179 4 1/2 X 4 1/2	US26D	ST
1 Lockset	45H-7AB15H PATD CORMAX PATENTED KEYING	626	BE
1 Closer	HD7016 AO8P	689	BE
1 Wall Bumper	1270CX	626	TR
3 Door Silencer	307D	GREY	HA

SET #04

Doors: 136B, 137B, 139B

3 Hinges	FBB179 4 1/2 X 4 1/2	US26D	ST
1 Lockset	45H-7AB15H PATD CORMAX PATENTED KEYING	626	BE
1 Closer	HD7016 AO8P	689	BE

200913 : NHC GOVERNMENT CENTER FITUPS

1 Wall Bumper	1270CX	626	TR
1 Gasketing	5050 B-17 17'		NA

SET #05

Doors: 145, 148, 151, 172, 234, 235, 247A, 247B, 259, 265, 275, 276, 334, 359, 367, 380, 432, 434, 435, 446A, 446B, 481, 497

3 Hinges	FBF179 4 1/2 X 4 1/2	US26D	ST
1 Lockset	45H-7D15H PATD CORMAX PATENTED KEYING	626	BE
1 Closer	HD7016 AO8P	689	BE
1 Wall Bumper	1270CX	626	TR
3 Door Silencer	307D	GREY	HA

SET #06

Doors: 438C, 439

3 Hinges	FBF179 4 1/2 X 4 1/2	US26D	ST
1 Lockset	45H-7D15H PATD CORMAX PATENTED KEYING	626	BE
1 Closer	HD7016 AO8P	689	BE
1 Wall Bumper	1270CX	626	TR
1 Gasketing	5050 B-17 17'		NA

SET #07

Doors: 128, 130, 149, 150, 159, 179, 236, 237, 273, 274, 336, 337, 436, 437

3 Hinges	FBF179 4 1/2 X 4 1/2	US26D	ST
1 Pull Plate	1018-3	630	TR
1 Closer	HD7016 AO8P	689	BE
1 Push Plate	1001-3	630	TR
1 Kick Plate	K0050 8" x 34"	630	TR
1 Mop Plate	KM050 4" x 35"	630	TR
1 Wall Bumper	1270CX	626	TR
3 Door Silencer	307D	GREY	HA

SET #08

Doors: 129, 154I, 156, 452

3 Hinges	FBF179 4 1/2 X 4 1/2	US26D	ST
1 Privacy Set	45H-0L15H	626	BE
1 Closer	HD7016 AO8P	689	BE
1 Kick Plate	K0050 8" x 34"	630	TR
1 Mop Plate	KM050 4" x 35"	630	TR
1 Wall Bumper	1270CX	626	TR
3 Door Silencer	307D	GREY	HA

SET #09

Doors: 131, 132, 133, 134, 135, 154D, 154E, 280, 281, 283, 284, 287

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NOTE: ALL HARDWARE BY GLASS DOOR SUPPLIER

SET #10

Doors: 136A, 137A, 138, 139A

6 Hinges	FBBI79 4 1/2 X 4 1/2	US26D	ST
1 Removable Mullion	KR822	689	PR
2 Exit Device	2108 X 4908A	630	PR
3 Mortise Cylinder	1E-74 PATD CORMAX PATENTED KEYING	626	BE
2 Closer	HD7016 DS	689	BE
2 Door Silencer	307D	GREY	HA

SET #11

Doors: 141, 233, 245, 333, 350, 433

6 Hinges	FBBI79 4 1/2 X 4 1/2	US26D	ST
1 Set Auto Flush Bolts	3815L X 3850	626	TR
1 Lockset	45H-7D15H PATD CORMAX PATENTED KEYING	626	BE
1 Coordinator	3094B2	BLACK	TR
2 Closer	HD7016 DS	689	BE
1 Gasketing	5050 B-20 20'		NA
1 Astragal	114 NA 84"		NA
2 Door Sweep	200 NA 36"		NA

SET #12

Doors: 144, 146

6 Hinges	FBBI79 4 1/2 X 4 1/2	US26D	ST
2 Flush Bolt	3915	626	TR
1 Lockset	45H-7D15H PATD CORMAX PATENTED KEYING	626	BE
2 Wall Bumper	1270CX	626	TR
1 Dustproof Strike	3910	626	TR
1 Astragal	114 NA 84"		NA
2 Door Silencer	307D	GREY	HA

SET #13

Doors: 154B, 154C, 163B, 171B

3 Hinges	FBBI79 4 1/2 X 4 1/2	US26D	ST
1 Lockset	45H-7AB15H PATD CORMAX PATENTED KEYING	626	BE
1 Closer	HD7016 AO8P	689	BE
1 Wall Bumper	1270CX	626	TR
3 Door Silencer	307D	GREY	HA

SET #14

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Doors: 154F, 154G, 154H, 154J

3 Hinges	FBB179 4 1/2 X 4 1/2	US26D	ST
1 Passage Set	45H-0N15H	626	BE
1 Wall Bumper	1270CX	626	TR
3 Door Silencer	307D	GREY	HA

SET #15

Doors: 279A

6 Hinges	FBB179 4 1/2 X 4 1/2	US26D	ST
2 Exit Device	2208 X 4908A	630	PR
2 Mortise Cylinder	1E-74 PATD CORMAX PATENTED KEYING	626	BE
2 Closer	HD7016 DS	689	BE
2 Wall Bumper	1270CX	626	TR
1 Gasketing Set	137 NA SET 84"		NA
2 Door Silencer	307D	GREY	HA

SET #16

Doors: 281A

2 Set Flush Pulls	1115B	630	TR
2 Sliding Door Hardware Kit	SLSS1-8-SC 98 7/16 CUT TO NET LENGTH		NA

SET #17

Doors: 438

2 Mortise Cylinder	1E-74 PATD CORMAX PATENTED KEYING	626	BE

NOTE: BALANCE OF HARDWARE BY GLASS DOOR SUPPLIER

SET #18 *REVISED*

Doors: 147A, 268

6 Hinges	FBB179 4 1/2 X 4 1/2	US26D	ST
2 Exit Device	FL 2208	630	PR
1 MAG LOCK SDC 1511 F	1511 F	626	VA01
2 Closer	HD7016 AO8P	689	BE
2 Wall Bumper	1270CX	626	TR
1 Power Supply	ELR151		PR
1 POWER SUPPLY SDC 631 RF	631 RF		VA01
1 Gasketing	5050 B-20 20'		NA
1 Smoke Seal	5070 B 72"		NA
1 Smoke Seal	5070 B 84"		NA

NOTE: 1 leaf to function with card reader for access. 2nd leaf to have free egress at all times.
BALANCE OF ACCESS CONTROL BY OTHERS

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Glass products.
 - 2. Glazing sealants.
 - 3. Glazing tapes.
 - 4. Miscellaneous glazing materials.

1.2 DEFINITIONS

- A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- B. Glass Thicknesses: Indicated by thickness designations in millimeters in accordance with ASTM C1036.
- C. IBC: International Building Code.
- D. Interspace: Space between lites of an insulating-glass unit.

1.3 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances to achieve proper safety margins for glazing retention under each design load case, load case combination, and service condition.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 2. Review temporary protection requirements for glazing during and after installation.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For glazing sealants, for tests performed by a qualified testing agency.

1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.

C. Preconstruction adhesion and compatibility test report.

1.7 QUALITY ASSURANCE

- A. Fabricated-Glass Manufacturer Qualifications: A qualified manufacturer of fabricated glass units who is approved and certified by primary glass manufacturer.
- B. Installer Qualifications: A qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AG&M) contractors.
- C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.
- D. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021 to conduct the testing indicated.

1.8 PRECONSTRUCTION TESTING

- A. Preconstruction Adhesion and Compatibility Testing: Test each glass product, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.
 1. Testing is not required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
 2. Use ASTM C1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
 3. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
 4. Schedule enough time for testing and analyzing results to prevent delaying the Work.
 5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials in accordance with manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
 1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Glazing Accessories: For each product and installation method, obtain from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

2.3 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. NGA Publications: "Glazing Manual."
- B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- C. Thickness: Where glass thickness is indicated, it is a minimum.
- D. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.4 GLASS PRODUCTS

- A. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
 - 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
- B. Heat-Strengthened Float Glass: ASTM C1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
 - 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

2.5 GLAZING SEALANTS

- A. General:
 - 1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
 3. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range of industry colors.
- B. Neutral-Curing Silicone Glazing Sealant, Class 100/50: Complying with ASTM C920, Type S, Grade NS, Use NT.
1. Products: Subject to compliance with requirements, provide the following:
 - a. Dow Corning Corporation; 790.
 - b. GE Advanced Materials - Silicones; SilPruf LM SCS2700.
 - c. May National Associates, Inc.; Bondaflex Sil 290.
 - d. Pecora Corporation; 890.
 - e. Sika Corporation, Construction Products Division; SikaSil-C990.
 - f. Tremco Incorporated; Spectrem 1.

2.6 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800 for products indicated below:
1. AAMA 804.3 tape, where indicated.
 2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
 3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
1. AAMA 810.1, Type 1, for glazing applications in which tape acts as primary sealant.
 2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.7 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, recommended in writing by manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks:
1. Elastomeric material with Shore A durometer hardness of 85, plus or minus 5.
 2. Type recommended in writing by sealant or glass manufacturer.
- D. Spacers:
1. Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
 2. Type recommended in writing by sealant or glass manufacturer.
- E. Edge Blocks:
1. Elastomeric material with Shore A durometer hardness per manufacturer's written instructions.

2. Type recommended in writing by sealant or glass manufacturer.

- F. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

2.8 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
- B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.
- C. Grind smooth and polish exposed glass edges and corners.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
 2. Minimum required face and edge clearances.
 3. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.
- C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

- D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- F. Provide spacers for glass lites where length plus width is larger than 50 inches.
 - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
 - 2. Provide 1/8-inch- minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and in accordance with requirements in referenced glazing publications.
- H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
- J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended in writing by gasket manufacturer.

3.4 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Do not remove release paper from tape until right before each glazing unit is installed.
- F. Apply heel bead of elastomeric sealant.
- G. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.
- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 CLEANING AND PROTECTION

- A. Immediately after installation, remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
 - 1. If, despite such protection, contaminating substances do contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.
- C. Remove and replace glass that is damaged during construction period.
- D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.8 MONOLITHIC GLASS SCHEDULE

- A. Clear Glass Type (GL3): Fully tempered float glass.
 - 1. Minimum Thickness: 6 mm.
 - 2. Safety glazing required.
- B. Clear Glass Type (GL8): Fully tempered float glass.
 - 1. Minimum Thickness: 12 mm.
 - 2. Safety glazing required.

END OF SECTION 088000

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing systems for interior partitions.
2. Suspension systems for interior ceilings and soffits.
3. Grid suspension systems for gypsum board ceilings.

B. Related Requirements:

1. Section 054000 "Cold-Formed Metal Framing" for exterior and interior load-bearing and exterior non-load-bearing wall studs; floor joists; and roof rafters and ceiling joists.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include Limiting Heights Table for each application.
2. For partitions requiring seismic bracing, submit coordinated set of partition anchorage drawings prior to installation including:
 - a. Description, layout, and location of items to be anchored or braced with anchorage or brace points noted and dimensioned.
 - b. Details of anchorage or bracing at large scale with all members, parts brackets shown, together with all connections, bolts, and welds clearly identified.
 - c. Numerical value of design seismic brace loads.
3. For head-of-wall fire-resistive joint systems incorporating proprietary firestop track with intumescent strips, include design designation and documentation, including illustrations, from a qualified testing and inspecting agency acceptable to authorities having jurisdiction that evidences compliance with requirements for each condition indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of code-compliance certification for studs and tracks.

B. Evaluation Reports: For embossed, high-strength steel studs and tracks, firestop tracks, post-installed anchors, and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E119 by an independent testing agency.

- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

2.2 FRAMING SYSTEMS

- A. Framing Members, General: Comply with ASTM C754 for conditions indicated.
 - 1. Steel Sheet Components: Comply with ASTM C645 requirements for steel unless otherwise indicated.
 - 2. Protective Coating: ASTM A653/A653M, G60, hot-dip galvanized unless otherwise indicated.
- B. Studs and Tracks: ASTM C645. Use either conventional steel studs and tracks or embossed, high-strength steel studs and tracks.
 - 1. Conventional Steel Studs and Runners:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Formetal Company, Inc.
 - 2) Phillips Manufacturing Co.
 - 3) Steel Network, Inc. (The).
 - 4) Telling Industries.
 - b. Minimum Base-Steel Thickness: As indicated in manufacturer's published "Limiting Heights" tables based on the following criteria, but not less than 0.0269 inch and 0.0312 for tile backing panels.
 - 1) Yield Strength of steel.
 - 2) Deflection Limits:
 - a) Gypsum Wallboard: L/240.
 - b) Ceramic Tile: L/360.
 - 3) Limiting Heights: As indicated on Drawings.
 - 4) Spans: As indicated on Drawings or as recommended by manufacturer.
 - 5) Applied loads, composite or non-composite construction, as appropriate:
 - a) Gypsum Wallboard: 5 psf.
 - b) Ceramic tile, one side: 15 psf.
 - c) Ceramic tile, two sides: 30 psf.
 - c. Depth: As indicated on Drawings.
 - 2. Embossed, High Strength Steel Studs and Tracks: Roll-formed and embossed with surface deformations to stiffen the framing members so that they are structurally comparable to conventional ASTM C645 steel studs and tracks.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) ClarkDietrich Building Systems.
 - 2) Marino\WARE.
 - 3) Phillips Manufacturing Co.
 - 4) Steel Network, Inc. (The).
 - 5) Telling Industries.
 - b. Minimum Base-Steel Thickness: Of equivalent thickness to conventional studs and runners, based on criteria above, and validated by independent, qualified third party testing.
 - c. Depth: As indicated on Drawings.

2.3 FRAMING ACCESSORIES

- A. Manufacturers: Unless indicated otherwise, provide framing accessories manufactured or approved by the manufacturer of the basic framing system.
- B. Slip-Type Head Joints: Provide one of the following:
 - 1. Single Long-Leg Track System: ASTM C645 top track with 2-inch- deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top track and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
 - 2. Double-Track System: ASTM C645 top outer tracks, inside track with 2-inch- deep flanges in thickness not less than indicated for studs and fastened to studs, and outer track sized to friction-fit over inner track.
 - 3. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- C. Firestop Tracks: Top track manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CEMCO; California Expanded Metal Products Co.; FAS Track.
 - b. ClarkDietrich; MaxTrak.
 - c. Fire Trak Corp; Fire Trak System attached to studs with Fire Trak Posi Klip.
 - d. MarinoWARE; Fas Ttrack.
 - e. SCAFCO Steel Stud Company; SCAFCO Slotted Leg Track System.
 - f. The Steel Network, Inc.; VertiTrack VT.
- D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
 - 1. Minimum Base-Steel Thickness: 0.0329 inch.
- E. Backing Plates (Contractor's Option): In lieu of flat steel straps provide ClarkDietrich Danback fire-retardant treated flexible wood backing plate system for the attachment of cabinets, handrails, wall fixtures.
- F. Cold-Rolled Channel Bridging: Steel, 0.0538-inch minimum base-steel thickness, with minimum 1/2-inch- wide flanges.
 - 1. Depth: As indicated on Drawings.
 - 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch- thick, galvanized steel.
- G. Hat-Shaped, Rigid Furring Channels: ASTM C645.
 - 1. Minimum Base-Steel Thickness: 0.033 inch.
 - 2. Depth: As indicated on Drawings.
- H. Resilient Furring Channels: 1/2-inch- deep, steel sheet members designed to reduce sound transmission.
 - 1. Configuration: Asymmetrical or hat shaped.
- I. Cold-Rolled Furring Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch- wide flanges.
 - 1. Depth: As indicated on Drawings.
 - 2. Furring Brackets: Adjustable, corrugated-edge-type steel sheet with minimum uncoated-steel thickness of 0.0329 inch.

3. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.

2.4 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.
- B. Hanger Attachments to Concrete:
 1. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01, AC193, AC58, or AC308 as appropriate for the substrate.
 - a. Uses: Securing hangers to structure.
 - b. Type: Torque-controlled, expansion anchor.
 - c. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.
 - d. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F593, and nuts, ASTM F594.
 2. Power-Actuated Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- C. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.
- D. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-steel thickness of 0.0538 inch and minimum 1/2-inch- wide flanges.
 1. Depth: As indicated on Drawings.
- E. Furring Channels (Furring Members):
 1. Cold-Rolled Channels: 0.0538-inch uncoated-steel thickness, with minimum 1/2-inch- wide flanges, 3/4 inch deep.
 2. Steel Studs and Tracks: ASTM C645.
 - a. Minimum Base-Steel Thickness: 0.033 inch.
 - b. Depth: As indicated on Drawings.
 3. Embossed, High-Strength Steel Studs and Tracks: ASTM C645.
 - a. Minimum Base-Steel Thickness: Not less than 0.0190 inch.
 - b. Depth: As indicated on Drawings.
 4. Hat-Shaped, Rigid Furring Channels: ASTM C645, 7/8 inch deep.
 - a. Minimum Base-Steel Thickness: Not less than 0.033 inch.
 5. Resilient Furring Channels: 1/2-inch- deep members designed to reduce sound transmission.
 - a. Configuration: Asymmetrical.
- F. Grid Suspension System for Gypsum Board Ceilings (Contractor's Option): ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Armstrong World Industries, Inc.; Drywall Grid Systems.
 - b. Chicago Metallic Corporation; Drywall Grid System.
 - c. USG Corporation; Drywall Suspension System.

- G. Corridor Suspension Systems for Gypsum Board Ceilings: System consisting of single runners that span width of corridors up to 7 feet without hanger wires and up to 14 feet with one hanger wire and are supported by wall angles.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Chicago Metallic Corporation; SpanFast Drywall Suspension System.
 - b. USG Corporation; Drywall Wall-to-Wall Suspension System.

2.5 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Isolation Strip at Exterior Walls: Provide the following:
1. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C754.
1. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.
- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.

- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
 - 1. Single-Layer Application: As required by horizontal deflection performance requirements unless otherwise indicated.
 - 2. Multilayer Application: As required by horizontal deflection performance requirements unless otherwise indicated.
 - 3. Tile Backing Panels: As required by horizontal deflection performance requirements unless otherwise indicated.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Install studs so flanges within framing system point in same direction.
- D. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.
 - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two studs at each jamb unless otherwise indicated.
 - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
 - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
 - 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
 - 4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
 - a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
 - 5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
- E. Direct Furring:
 - 1. Screw to framing.
 - 2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
- F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.5 INSTALLING CEILING SUSPENSION SYSTEMS

- A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
 - 1. Hangers: 48 inches o.c.
 - 2. Carrying Channels (Main Runners): 48 inches o.c.
 - 3. Furring Channels (Furring Members): 16 inches o.c.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
 - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
 - 3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 - 4. Do not attach hangers to steel roof deck.
 - 5. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
 - 6. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
 - 7. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.
- F. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
- G. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 092216

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Interior gypsum board.
 2. Tile backing panels.

1.2 ACTION SUBMITTALS

- A. Product Data: For the following:
1. Gypsum board, Type X.
 2. Gypsum ceiling board.
 3. Mold-resistant gypsum board.
 4. Cementitious backer units.
 5. Interior trim.
 6. Joint treatment materials.
 7. Sound-attenuation blankets.
 8. Acoustical sealant.

1.3 QUALITY ASSURANCE

- A. Mockups: Build mockups of at least 100 sq. ft. in surface area to demonstrate aesthetic effects and to set quality standards for materials and execution.
1. Build mockups for the following:
 - a. Each level of gypsum board finish indicated for use in exposed locations.
 2. Apply or install final decoration indicated, including painting and wallcoverings, on exposed surfaces for review of mockups.
 3. Simulate finished lighting conditions for review of mockups.
 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

- A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. American Gypsum.
 2. Certaineed Corporation
 3. Georgia-Pacific Gypsum LLC
 4. National Gypsum Company
 5. USG Corporation.

2.4 INTERIOR GYPSUM BOARD

- A. Gypsum Board, Type X: ASTM C1396/C1396M.
 1. Thickness: 5/8 inch.
 2. Long Edges: Tapered and featured (rounded or beveled) for prefilling.
- B. Gypsum Ceiling Board: ASTM C1396/C1396M.
 1. Thickness: 5/8 inch.
 2. Long Edges: Tapered.
- C. Mold-Resistant Gypsum Board: ASTM C1396/C1396M. With moisture- and mold-resistant core and paper surfaces.
 1. Core: 5/8 inch, Type X.
 2. Long Edges: Tapered.
 3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.5 TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A118.9 and ASTM C1288 or ASTM C1325, with manufacturer's standard edges.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. C-Cure
 - b. CertainTeed Corporation; Saint-Gobain North America.
 - c. Custom Building Products.
 - d. FinPan, Inc.
 - e. James Hardie Building Products, Inc.
 - f. National Gypsum Company.
 - g. USG Corporation.
 - 2. Thickness: 5/8 inch.
 - 3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.6 TRIM ACCESSORIES

- A. Interior Trim: ASTM C1047.
 - 1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
 - 2. Shapes:
 - a. Cornerbead.
 - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - c. L-Bead: L-shaped; exposed long flange receives joint compound.
 - d. U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - e. Expansion (control) joint.
- B. Partition Closures: Two-piece spring-loaded extruded aluminum partition closure. Provide continuous length for height of wall up to ten feet.
 - 1. Basis of Design: Subject to compliance with requirements, provide basis of design indicated or comparable product by one of the following:
 - a. Gordon, Inc.; Mullion Mate (Basis of Design)
 - b. Mull It Over Products
 - 2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221, Alloy 6063-T5.
 - 3. Finish: Class I, dark bronze anodized to match window mullion.

2.7 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C475/C475M.
- B. Joint Tape: Paper.
- C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
 - 1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
 - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use joint setting compound.

3. Fill Coat: For second coat, use joint setting compound.
4. Finish Coat: For third coat, use drying-type compound.
5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound.

D. Joint Compound for Tile Backing Panels:

1. Cementitious Backer Units: As recommended by backer unit manufacturer.

2.8 AUXILIARY MATERIALS

- A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
- C. Steel Drill Screws: ASTM C1002 unless otherwise indicated.
 1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- D. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
- E. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."
- F. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION AND FINISHING OF PANELS, GENERAL

- A. Comply with ASTM C840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C919 and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- J. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 INSTALLATION OF INTERIOR GYPSUM BOARD

A. Single-Layer Application:

- 1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
- 2. On partitions/walls, apply gypsum panels vertically (parallel to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 - b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
- 3. On Z-shaped furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
- 4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

B. Multilayer Application:

- 1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.

2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
 3. Fastening Methods: Fasten base layers and face layers separately to supports with screws.
- C. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written instructions and temporarily brace or fasten gypsum panels until fastening adhesive has set.

3.4 INSTALLATION OF TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A108.11, at locations indicated to receive tile.
- B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.5 INSTALLATION OF TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints according to ASTM C840 and in specific locations approved by Architect for visual effect.
- C. Interior Trim: Install in the following locations:
1. Cornerbead: Use at outside corners unless otherwise indicated.
 2. LC-Bead: Use at exposed panel edges.
 3. L-Bead: Use where indicated.
 4. U-Bead: Use at exposed panel edges.

3.6 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints, rounded or beveled edges, and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:
1. Level 0: This level of finish shall be used in temporary construction only. No taping, finishing, or accessories required unless indicated or specified as in dust proof partitions.
 2. Level 1: This level shall be used in ceiling plenum areas and concealed areas unless a higher level of finish is required for fire-resistance-rated assemblies and sound-rated assemblies. Embed tape at joints.
 3. Level 2: This level of finish shall be used where water resistant gypsum backing board is used as a substrate for tile. Embed tape and apply separate first coat of joint compound to tape, fasteners, and trim flanges where indicated.

4. Level 3: This level of finish shall be used in areas to receive heavy textured, thick (1/8 inch or greater) wall coverings and where indicated. Embed tape and apply separate first and finish coats of joint compound to tape, fasteners, and trim flanges.
5. Level 4: This level of finish shall be used for areas to receive smooth paint finish. Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges at panel surfaces.
 - a. Tape joints require joint compound and feathering of joint to a minimum of 12 inches each side of joint.
 - b. Tape joints that are visible through finished walls are not acceptable.
6. Level 5: This level of finish shall be used in areas as indicated on Drawings. Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges. A thin skim coat of joint compound, or a material manufactured especially for this purpose, shall be applied to the entire surface. The surface shall be smooth and free of tool marks and ridges.

E. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.7 FIELD QUALITY CONTROL

- A. Above-Ceiling Observation: Before Contractor installs gypsum board ceilings, Owner will conduct an above-ceiling observation and report deficiencies in the Work observed. Do not proceed with installation of gypsum board to ceiling support framing until deficiencies have been corrected.
1. Notify Owner seven days in advance of date and time when Project, or part of Project, will be ready for above-ceiling observation.
 2. Before notifying Owner, complete the following in areas to receive gypsum board ceilings:
 - a. Installation of 80 percent of lighting fixtures, powered for operation.
 - b. Installation, insulation, and leak and pressure testing of water piping systems.
 - c. Installation of air-duct systems.
 - d. Installation of air devices.
 - e. Installation of mechanical system control-air tubing.
 - f. Installation of ceiling support framing.
 - g. Installation of through-penetration firestopping and fire-resistant joint sealants, with identification labels.

3.8 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

SECTION 093013 - CERAMIC TILING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Porcelain mosaic tile.
2. Porcelain tile.
3. Glazed wall tile - shower wall tile to be determined
4. Thresholds.
5. Waterproof membranes.
6. Crack isolation membranes.

B. Related Requirements:

1. Section 079200 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.
2. Section 092900 "Gypsum Board" for cementitious backer units.
3. Section 093023 "Glass Tiling."

1.2 DEFINITIONS

- A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
- B. Face Size: Actual tile size, excluding spacer lugs.
- C. Module Size: Actual tile size plus joint width indicated.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
- C. Samples: For tile, grout, and accessories involving color selection.
- D. Samples for Verification:
 1. Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required. Make samples at least 36 inches square, but not fewer than four tiles. Use grout of type and in color or colors approved for completed Work.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.
- C. Product Certificates: For each type of product.
- D. Product Test Reports: For tile-setting and -grouting products.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.
 - 2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer who has completed tile installations similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build mockup of each type of floor tile installation.
 - 2. Build mockup of each type of wall tile installation.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
- D. Store liquid materials in unopened containers and protected from freezing.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Tile: Obtain tile of each type and color or finish from single source or producer.
 - 1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.
- B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.
 - 1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.
- C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer:
 - 1. Stone thresholds.
 - 2. Waterproof membrane.
 - 3. Crack isolation membrane.

2.2 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
 - 1. Provide tile complying with Standard grade requirements.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.
- C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.
- D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.
 - 1. Where tile is indicated for installation in wet areas, do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.

2.3 TILE PRODUCTS

- A. Factory-Mounted Mosaic Tile Type **(PTF-4)**:
 - 1. Basis of Design: Del Conca USA; Tudor Stone.
 - 2. Composition: Porcelain.
 - 3. Module Size: 2 by 2 inches.
 - 4. Face: Plain with cushion edges.
 - 5. Surface: Smooth, without abrasive admixture.
 - 6. Dynamic Coefficient of Friction: Not less than 0.42.
 - 7. Tile Color and Pattern: As indicated on Material Finishes Legend.

8. Grout Color: As selected by Architect from manufacturer's full range.

B. Porcelain Tile Type (**PTF-1, PTW-1**):

1. Basis of Design: Del Conca USA; Tudor Stone.
2. Face Size: 12 by 24 inches.
3. Face Size Variation: Rectified.
4. Face: Plain with cushion edges.
5. Dynamic Coefficient of Friction: Not less than 0.42.
6. Tile Color, Glaze, and Pattern: As indicated on Material Finishes Legend.
7. Grout Color: As selected by Architect from manufacturer's full range.
8. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
 - a. Base (**PTB-2**): Same as adjoining flat tile, 6 by 24 inches, with metal trim.

C. Porcelain Tile Type (**PTF-2, PTF-3**):

1. Basis of Design: Atlas Concorde; Marine
2. Face Size:
 - a. PTF-2: 12 by 24 inches.
 - b. PTF-3: 24 by 48 inches.
3. Face Size Variation: Rectified.
4. Face: Plain with cushion edges.
5. Dynamic Coefficient of Friction: Not less than 0.42.
6. Tile Color, Glaze, and Pattern: As indicated on Material Finishes Legend.
7. Grout Color: As selected by Architect from manufacturer's full range.
8. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
 - a. Base (**PTB-1**): Cove base, 6 by 12 inches.

2.4 THRESHOLDS

- A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.
1. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to 1/16 inch above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to 1/2 inch or less above adjacent floor surface.
- B. Marble Thresholds: ASTM C503/C503M, with a minimum abrasion resistance of 10 according to ASTM C1353 or ASTM C241/C241M and with honed finish.
1. Description: Uniform, fine- to medium-grained white stone with gray veining.

2.5 WATERPROOF MEMBRANES

- A. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and continuous fabric reinforcement.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Bonsal American; an Oldcastle company; B 6000 Waterproof Membrane with Glass Fabric.
 - b. Custom Building Products; 9240 Waterproofing and Anti-Fracture Membrane.
 - c. Laticrete International, Inc.; Laticrete 9235 Waterproof Membrane.
 - d. MAPEI Corporation; Mapelastic HPG with MAPEI Fiberglass Mesh.
- C. Shower Pan Liner: Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; 0.030-inch nominal thickness.

2.6 CRACK ISOLATION MEMBRANES

- A. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.12 for standard performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and fabric reinforcement.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Bonsal American; an Oldcastle company; B 6000 Waterproof Membrane with Glass Fabric
 - b. Custom Building Products; 9240 Waterproofing and Anti-Fracture Membrane
 - c. Laticrete International, Inc.; Laticrete Blue 92 Anti-Fracture Membrane
 - d. MAPEI Corporation; Mapelastic HPG with MAPEI Fiberglass Mesh

2.7 SETTING MATERIALS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Bonsal American; an Oldcastle company
 2. Custom Building Products
 3. Laticrete International, Inc.
 4. MAPEI Corporation
 5. Southern Grouts & Mortars, Inc.
 6. Summitville Tiles, Inc.
 7. TEC; a subsidiary of H. B. Fuller Company
- B. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.02.
 1. Cleavage Membrane: Asphalt felt, ASTM D226/D226M, Type I (No. 15); or polyethylene sheeting, ASTM D4397, 4.0 mils thick.
 2. Reinforcing Wire Fabric: Galvanized, welded-wire fabric, 2 by 2 inches by 0.062-inch diameter; comply with ASTM A185/A185M and ASTM A82/A82M, except for minimum wire size.
 3. Latex Additive: Manufacturer's standard acrylic resin or styrene-butadiene-rubber water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed.
- C. Modified Dry-Set Mortar (Thinset): ANSI A118.4.
 1. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
 2. Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.

3. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.
- D. Medium-Bed, Modified Dry-Set Mortar: Comply with requirements in ANSI A118.4. Provide product that is approved by manufacturer for application thickness of 5/8 inch.
 1. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
 2. Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.

2.8 GROUT MATERIALS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Bonsal American; an Oldcastle company
 2. Custom Building Products
 3. Laticrete International, Inc.
 4. MAPEI Corporation
 5. Southern Grouts & Mortars, Inc.
 6. Summitville Tiles, Inc.
 7. TEC; a subsidiary of H. B. Fuller Company
- B. High-Performance Tile Grout: ANSI A118.7.
 1. Polymer Type: Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.
- C. Water-Cleanable Epoxy Grout: ANSI A118.3.

2.9 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
- B. Metal Edge Trim: Stainless steel, brushed finish.
 1. Basis of Design: Schluter; SCHIENE
- C. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.
- D. Floor Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.

2.10 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
- B. Add materials, water, and additives in accurate proportions.
- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
 - 2. Verify that concrete substrates for tile floors comply with surface finish requirements in ANSI A108.01 for installations indicated.
 - a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
 - b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
 - 3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
 - 4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- B. Where indicated, prepare substrates to receive waterproof membrane by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot toward drains.
- C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 INSTALLATION OF CERAMIC TILE

- A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
 - 1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
 - a. Tile floors in wet areas.
 - b. Tile floors consisting of tiles 8 by 8 inches or larger.
 - c. Tile floors consisting of rib-backed tiles.
- B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
 - D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
 - E. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.
 - F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
 - 1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
 - 2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
 - 3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.
 - G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
 - 1. Porcelain Mosaic Tile: 1/8 inch.
 - 2. Glazed Wall Tile: [1/16 inch] [1/8 inch].
 - 3. Porcelain Tile: 1/4 inch.
 - H. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.
 - I. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
 - 1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
 - J. Stone Thresholds: Install stone thresholds in same type of setting bed as adjacent floor unless otherwise indicated.
 - 1. Do not extend cleavage membrane, waterproof membrane, or crack isolation membrane under thresholds set in modified dry-set mortar. Fill joints between such thresholds and adjoining tile set on cleavage membrane, waterproof membrane, or crack isolation membrane with elastomeric sealant.
 - K. Metal Edge Strips: Install at locations indicated.
 - L. Floor Sealer: Apply floor sealer to grout joints in tile floors according to floor-sealer manufacturer's written instructions. As soon as floor sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.
- 3.4 INSTALLATION OF WATERPROOF MEMBRANES
- A. Install waterproof membrane to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.
 - B. Allow waterproof membrane to cure and verify by testing that it is watertight before installing tile or setting materials over it.

3.5 INSTALLATION OF CRACK ISOLATION MEMBRANES

- A. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.
- B. Allow crack isolation membrane to cure before installing tile or setting materials over it.

3.6 ADJUSTING AND CLEANING

- A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.
- B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
 - 1. Remove grout residue from tile as soon as possible.
 - 2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3.7 PROTECTION

- A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
- B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.8 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

- A. Interior Floor Installations, Concrete Subfloor:
 - 1. TCNA F111: Cement mortar bed (thickset) with cleavage membrane.
 - a. Ceramic Tile Type: Porcelain floor tile.
 - b. Bond Coat for Cured-Bed Method: Medium-bed, modified dry-set mortar.
 - c. Grout: High-performance sanded grout.
 - 2. TCNA F121: Cement mortar bed (thickset) on waterproof membrane.
 - a. Ceramic Tile Type: Porcelain floor tile in wet areas.
 - b. Bond Coat for Cured-Bed Method: Modified dry-set mortar.
 - c. Grout: Water-cleanable epoxy grout.
- B. Interior Wall Installations, Wood or Metal Studs or Furring:
 - 1. TCNA W244C or TCNA W244F: Thinset mortar on cementitious backer units or fiber-cement backer board.
 - a. Ceramic Tile Type: Porcelain wall tile.
 - b. Thinset Mortar: Modified dry-set mortar.
 - c. Grout: High-performance unsanded grout.

C. Shower Wall Installations, Wood or Metal Studs or Furring:

1. TCNA B415: Thinset mortar on waterproof membrane over cementitious backer units.
 - a. Ceramic Tile Type: **To be determined.**
 - b. Thinset Mortar: Modified dry-set mortar.
 - c. Grout: Water-cleanable epoxy grout.

END OF SECTION 093013

SECTION 093023 - GLASS TILING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glass tile.

B. Related Requirements:

1. Section 079200 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.
2. Section 092900 "Gypsum Board" for cementitious backer units.

1.2 DEFINITIONS

- A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.2 apply to Work of this Section unless otherwise specified.
- B. Face Size: Actual tile size, excluding spacer lugs.
- C. Module Size: Actual tile size plus joint width indicated.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Indicate locations of each type of tile and tile pattern. Indicate widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
- C. Samples for Verification:
 1. Full-size units of each type and composition of tile and for each color and finish required. For glass tile in color blend patterns, provide full sheets of each color blend.
 2. Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required. Make samples at least 12 inches square, but not fewer than four tiles. Use grout of type and in color or colors approved for completed Work.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.

- C. Product Certificates: For each type of product.
- D. Product Test Reports: For tile-setting and -grouting products.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Material: Furnish extra materials, from same production run, to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Tile Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.
 - 2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer who has completed tile installations similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

1.8 MOCKUPS

- A. Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build mockup as indicated on Drawings.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
 - 3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.2 for labeling tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
- D. Store liquid materials in unopened containers and protected from freezing.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Source Limitations for Tile: Obtain tile of each type and color or finish from single source or producer.
 - 1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.
- B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.
 - 1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.
- C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer:
 - 1. Joint sealants.
 - 2. Cementitious backer units.

2.2 PRODUCTS, GENERAL

- A. ANSI Glass Tile Standard: Provide glass tile that complies with ANSI A137.2 for types and other characteristics indicated.
 - 1. Provide tile complying with Standard grade requirements.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.
- C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.
- D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.

2.3 TILE PRODUCTS

- A. Factory-Mounted Mosaic Glass-Tile Type **(PTW-2)**:
 - 1. Basis of Design: Best Tile; Shimmer
 - 2. Module Size: 3 by 6 inches, elongated hexagon.
 - 3. Tile Color and Pattern: As indicated on Material Finishes Legend.
 - 4. Grout Color: As selected by Architect from manufacturer's full range.

2.4 SETTING MATERIALS

- A. Modified Dry-Set Mortar (Thinset): ANSI A118.4.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Bonsal American; an Oldcastle company
 - b. Custom Building Products
 - c. Laticrete International, Inc.
 - d. MAPEI Corporation
 - e. Southern Grouts & Mortars, Inc.
 - f. Summitville Tiles, Inc.
 - g. TEC; a subsidiary of H. B. Fuller Company
2. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
3. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.

2.5 GROUT MATERIALS

A. High-Performance Tile Grout: ANSI A118.7.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bonsal American; an Oldcastle company
 - b. Custom Building Products
 - c. Laticrete International, Inc.
 - d. MAPEI Corporation
 - e. Southern Grouts & Mortars, Inc.
 - f. Summitville Tiles, Inc.
 - g. TEC; a subsidiary of H. B. Fuller Company
2. Polymer Type: Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.

2.6 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
- B. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.
- C. Grout Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.

2.7 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
- B. Add materials, water, and additives in accurate proportions.
- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
 - 2. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
 - 3. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 INSTALLATION OF GLASS TILE

- A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
- B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- D. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
 - 1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
- E. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
 - 1. Factory-Mounted Mosaic Glass Tile: 1/16 inch.
- F. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.

- G. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
- H. Grout Sealer: Apply grout sealer to grout joints in accordance with grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.4 CLEANING AND PROTECTING

- A. Cleaning: On completion of placement and grouting, clean all tile surfaces so they are free of foreign matter.
 - 1. Remove grout residue from tile as soon as possible.
 - 2. Clean grout smears and haze from tile in accordance with tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.
 - 3. Remove temporary protective coating by method recommended by coating manufacturer and that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent drain clogging.
- B. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls.
- C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.5 INTERIOR GLASS TILE INSTALLATION SCHEDULE

- A. Interior Wall Installations, Wood or Metal Studs or Furring:
 - 1. TCNA W244C or TCNA W244F: Thinset mortar on cementitious backer units.
 - a. Thinset Mortar: Modified dry-set mortar.
 - b. Grout: High-performance unsanded grout.

END OF SECTION 093023

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes acoustical panels and exposed suspension systems for interior ceilings.
- B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, 6 inches in size.
- C. Delegated-Design Submittal: For seismic restraints for ceiling systems.
 - 1. Include design calculations for seismic restraints including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Ceiling suspension-system members.
 - 2. Structural members to which suspension systems will be attached.
 - 3. Method of attaching hangers to building structure.
 - a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.
 - 4. Carrying channels or other supplemental support for hanger-wire attachment where conditions do not permit installation of hanger wires at required spacing.
 - 5. Size and location of initial access modules for acoustical panels.
 - 6. Items penetrating finished ceiling and ceiling-mounted items including the following:
 - a. Lighting fixtures.
 - b. Diffusers.
 - c. Grilles.
 - d. Speakers.
 - e. Sprinklers.
 - f. Access panels.
 - g. Perimeter moldings.
 - 7. Show operation of hinged and sliding components covered by or adjacent to acoustical panels.
 - 8. Minimum Drawing Scale: 1/8 inch = 1 foot.

- B. Evaluation Reports: For each acoustical panel ceiling suspension system and anchor and fastener type, from ICC-ES.
- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For finishes to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Acoustical Ceiling Units: Full-size panels equal to 2 percent of quantity installed.
 - 2. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed.
 - 3. Hold-Down Clips: Equal to 2 percent of quantity installed.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
 - 1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of acoustical ceiling panel and its supporting suspension system from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic restraints for ceiling systems.
- B. Seismic Performance: Suspended ceilings shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

- C. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: Class A according to ASTM E1264.
 - 2. Smoke-Developed Index: 50 or less.
- D. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Indicate design designations from UL or from the listings of another qualified testing agency.

2.3 ACOUSTICAL PANELS

- A. Basis of Design: Subject to compliance with requirements, provide basis of design indicated or comparable product by one of the following:
 - 1. Armstrong World Industries.
 - 2. CertainTeed Corp.
 - 3. USG Corp.
- B. Acoustical Panel Standard: Provide manufacturer's standard panels according to ASTM E1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.
- C. Acoustical Panel Ceilings: **(ACT-1)**
 - 1. Basis of Design: Armstrong; Ultima 1912.
 - 2. Type and Form: Type IV, mineral base with membrane-faced overlay; Form 2, water felted.
 - 3. Pattern: E (lightly textured).
 - 4. Color: White.
 - 5. Light Reflectance (LR): Not less than 0.88.
 - 6. Ceiling Attenuation Class (CAC): Not less than 35.
 - 7. Noise Reduction Coefficient (NRC): Not less than 0.75.
 - 8. Edge/Joint Detail: Beveled tegular.
 - 9. Thickness: 3/4 inch.
 - 10. Modular Size: 24 by 24 inches.
- D. Acoustical Panel Ceilings: **(ACT-2)**
 - 1. Basis of Design: Armstrong; Optima 3252.
 - 2. Type and Form: Type XII, glass-fiber base with membrane-faced overlay; Form 2, cloth. Binder shall not contain urea formaldehyde.
 - 3. Pattern: E (lightly textured).
 - 4. Color: White.
 - 5. Light Reflectance (LR): Not less than 0.88.
 - 6. Noise Reduction Coefficient (NRC): Not less than 0.95.
 - 7. Articulation Class (AC): Not less than 190.
 - 8. Edge/Joint Detail: Square tegular.
 - 9. Thickness: 1-inch.
 - 10. Modular Size: 24 by 48 inches.
- E. Acoustical Panel Ceilings: **(ACT-3)**
 - 1. Basis of Design: Armstrong; Optima 3154.
 - 2. Type and Form: Type XII, glass-fiber base with membrane-faced overlay; Form 2, cloth. Binder shall not contain urea formaldehyde.
 - 3. Pattern: E (lightly textured).
 - 4. Color: White.

5. Light Reflectance (LR): Not less than 0.88.
6. Noise Reduction Coefficient (NRC): Not less than 0.95.
7. Articulation Class (AC): Not less than 190.
8. Edge/Joint Detail: Square Lay-in.
9. Thickness: 1-inch.
10. Modular Size: 48 by 96 inches.

F. Acoustical Panel Ceilings: **(ACT-4)**

1. Basis of Design: Armstrong; Optima 1414.
2. Type and Form: Type XII, glass-fiber base with membrane-faced overlay; Form 2, cloth. Binder shall not contain urea formaldehyde.
3. Pattern: E (lightly textured).
4. Color: White.
5. Light Reflectance (LR): Not less than 0.88.
6. Noise Reduction Coefficient (NRC): Not less than 0.95.
7. Articulation Class (AC): Not less than 190.
8. Edge/Joint Detail: Square tegular.
9. Thickness: 1- inch.
10. Modular Size: 12 by 96 inches.

G. Acoustical Panel Ceilings: **(ACT-5)**

1. Basis of Design: Armstrong; Calla.
2. Color: Custom color as selected by Architect.
3. Light Reflectance (LR): Not less than 0.85.
4. Ceiling Attenuation Class (CAC): Not less than 35.
5. Noise Reduction Coefficient (NRC): Not less than 0.85.
6. Articulation Class (AC): Not less than 170.
7. Edge/Joint Detail: Square tegular.
8. Modular Size: Custom, 24 by 96 inches.

H. Antimicrobial Treatment: Manufacturer's standard broad spectrum, antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D3273, ASTM D3274, or ASTM G21 and evaluated according to ASTM D3274 or ASTM G21.

I. Humidity Resistance: Manufacturer's standard.

2.4 METAL SUSPENSION SYSTEM

A. Manufacturers: Subject to compliance with requirements, provide products from one of the following:

1. Armstrong World Industries.
2. CertainTeed Corp.
3. USG Corp.

B. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, metal suspension system and accessories according to ASTM C635/C635M and designated by type, structural classification, and finish indicated.

1. High-Humidity Finish: Where indicated, provide coating tested and classified for "severe environment performance" according to ASTM C635/C635M.

- C. Wide-Face, Capped, Double-Web, Steel Suspension System (**ACT-2, ACT-3**): Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 coating designation; with prefinished 15/16-inch- wide metal caps on flanges.
1. Basis of Design: Armstrong World Industries; Prelude XL.
 2. Structural Classification: Intermediate -duty system.
 3. End Condition of Cross Runners: Override (stepped) type.
 4. Face Design: Flat, flush.
 5. Cap Material: Cold-rolled steel.
 6. Cap Finish: Painted white.
- D. Narrow-Face, Capped, Double-Web, Steel Suspension System (**ACT-1, ACT-4**): Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 coating designation; with prefinished 9/16-inch- wide metal caps on flanges.
1. Basis of Design: Armstrong World Industries; Suprafine XL
 2. Structural Classification: Intermediate-duty system.
 3. End Condition of Cross Runners: Override (stepped) type.
 4. Face Design: Flat, flush.
 5. Cap Material: Cold-rolled steel.
 6. Cap Finish: Painted white.
- E. Narrow-Face, Capped, Double-Web, Steel Suspension System (**ACT-5**): Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 coating designation; with prefinished 9/16-inch- wide metal caps on flanges.
1. Basis of Design: Armstrong World Industries; Silhouette
 2. Structural Classification: Intermediate-duty system.
 3. End Condition of Cross Runners: Override (stepped) type.
 4. Face Design: Flanges formed with a 1/4-inch integral center reveal.
 5. Cap Material: Cold-rolled steel.
 6. Cap Finish: Custom color as selected by Architect.

2.5 ACCESSORIES

- A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
- B. Wire Hangers, Braces, and Ties: Provide wires as follows:
1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
 2. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C635/C635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than 0.106-inch- diameter wire.
- C. Hold-Down Clips: Manufacturer's standard hold-down.
- D. Seismic Clips: Manufacturer's standard seismic clips designed to secure acoustical panels in place during a seismic event.
- E. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.
- F. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.

2.6 METAL EDGE MOLDINGS AND TRIM

- A. Basis of Design: Subject to compliance with requirements, provide products by one of the following:
1. Armstrong World Industries.
 2. CertainTeed Corp.
 3. USG Corp.
- B. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
1. Edge moldings shall fit acoustical panel edge details and suspension systems indicated and match width and configuration of exposed runners unless otherwise indicated.
 2. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
 3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
 4. For sprinkler heads and other penetrations, provide 2-inch oversized ring or sleeve through the ceiling to allow for free movement of at least 1 inch in all horizontal directions.
 5. Wall Angle: 7/8-inch wide, approved for use in seismic areas.
 - a. Armstrong Seismic RX with BERC2 Clips.
 - b. CertainTeed; CTSPC clips system
 - c. USG; DX main and cross runners with ACM7 clips.
- C. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements.
1. Basis of Design:
 - a. **TRM-1:** Armstrong; Classic AX2STRWH
 - b. **TRM-2:** Armstrong; Knife Edge AXKE5STR
 2. Powder-Coat Finish: Minimum dry film thickness of 1.5 mils. Comply with ASTM C635/C635M and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 - a. Color: White.

2.7 AUXILIARY MATERIALS

- A. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."
- B. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.
- B. Layout openings for penetrations centered on the penetrating items.

3.3 INSTALLATION

- A. Install acoustical panel ceilings according to ASTM C636/C636M, seismic design requirements, and manufacturer's written instructions.
- B. Suspend ceiling hangers from building's structural members and as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 - 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 - 4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly to structure or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 - 5. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 - 6. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 - 7. Do not attach hangers to steel deck tabs.
 - 8. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 - 9. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
 - 10. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.

11. Install hanger wire as specified above within 6 inches of each corner of the grid at every light, air diffuser, air return grille, and other equipment items which are installed within or penetrate the ceiling system.
- C. Where area of ceiling exceeds 2500 square feet provide seismic separation joints as indicated, or, if not indicated, as directed by Architect.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
 1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends. Miter corners accurately and connect securely.
 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
 4. Install seismic edge molding in accordance with manufacturer's written recommendations with all accessories necessary to comply with ICC evaluation report.
- E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide precise fit.
 1. Arrange directionally patterned acoustical panels as follows:
 - a. As indicated on reflected ceiling plans.
 2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
 3. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
 4. For reveal-edged panels on suspension-system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension-system surfaces and panel faces flush with bottom face of runners.
 5. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
 6. Install seismic clips in areas indicated; space according to panel manufacturer's written instructions unless otherwise indicated.
 7. Install hold-down clips at entrances and in areas required by authorities having jurisdiction; space as recommended by panel manufacturer's written instructions, unless otherwise indicated.
 8. Protect lighting fixtures and air ducts according to requirements indicated for fire-resistance-rated assembly.

3.4 ERECTION TOLERANCES

- A. Suspended Ceilings: Install main and cross runners level to a tolerance of 1/8 inch in 12 feet, non-cumulative.
- B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of 1/8 inch in 12 feet, non-cumulative.

3.5 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Periodic inspection during the installation of suspended ceiling grids according to ASCE/SEI 7.
- B. Acoustical panel ceiling hangers, anchors, and fasteners will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.6 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.
- B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Thermoplastic-rubber base.
 - 2. Rubber molding accessories.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, not less than 12 inches long.
- C. Product Schedule: For resilient base and accessory products. Use same designations indicated on Drawings.

1.3 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.4 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Coordinate mockups in this Section with mockups specified in other Sections.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

1.6 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.

- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 THERMOPLASTIC-RUBBER BASE (**RBS-1, RBS-2, RBS-3**)

- A. Basis of Design: Tarkett; Traditional Duracove
- B. Product Standard: ASTM F1861, Type TP (rubber, thermoplastic).
 - 1. Group: I (solid, homogeneous).
 - 2. Style and Location: Style B, Cove.
- C. Thickness: 0.125 inch.
- D. Height: 4 inches.
- E. Lengths: Coils in manufacturer's standard length.
- F. Outside Corners: Preformed.
- G. Inside Corners: Job formed.
- H. Colors: As indicated on Material Finishes Legend.

2.2 RUBBER MOLDING ACCESSORY

- A. Description: Rubber stair nosing for carpet, reducer strip for resilient floor covering and transition strips.
- B. Profile and Dimensions: As selected by Architect.
- C. Colors and Patterns: As selected by Architect from manufacturer's full range.

2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.
- C. Stair-Tread Nose Filler: Two-part epoxy compound recommended by resilient stair-tread manufacturer to fill nosing substrates that do not conform to tread contours.

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates for Resilient Stair Accessories: Prepare horizontal surfaces according to ASTM F710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
 - 3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
 - 4. Moisture Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install resilient products until materials are the same temperature as space where they are to be installed.
 - 1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

- E. Do not stretch resilient base during installation.
- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Preformed Corners: Install preformed corners before installing straight pieces.
- H. Job-Formed Corners:
 - 1. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
 - a. Miter or cope corners to minimize open joints.

3.4 RESILIENT ACCESSORY INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient accessories.
- B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.5 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Perform the following operations immediately after completing resilient-product installation:
 - 1. Remove adhesive and other blemishes from surfaces.
 - 2. Sweep and vacuum horizontal surfaces thoroughly.
 - 3. Damp-mop horizontal surfaces to remove marks and soil.
- C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 096513

SECTION 096519 - RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Vinyl composition floor tile.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product specified.
- B. Shop Drawings: For each type of floor tile. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
 - 1. Show details of special patterns.
- C. Samples: Tiles of each different color and pattern of resilient floor tile specified, showing the full range of variations expected in these characteristics.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: Signed by manufacturers of resilient products certifying that each product furnished complies with requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For resilient floor tile to include in the maintenance manuals specified in Division 01.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer to perform work of this Section who has specialized in installing resilient products similar to those required for this Project and with a record of successful in-service performance.
- B. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
- C. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build mockups for floor tile including resilient base and accessories.
 - 2. Size: Minimum 100 sq. ft. for each type, color, and pattern in locations directed by Architect.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to Project site in manufacturer's original, unopened cartons and containers, each bearing names of product and manufacturer, Project identification, and shipping and handling instructions.
- B. Store products in dry spaces protected from the weather, with ambient temperatures maintained between 50 and 90 deg F. Store tiles on flat surfaces.
- C. Move products into spaces where they will be installed at least 48 hours before installation, unless longer conditioning period is recommended in writing by manufacturer.

1.7 PROJECT CONDITIONS

- A. Maintain a temperature of not less than 70 deg F or more than 95 deg F in spaces to receive products for at least 48 hours before installation, during installation, and for at least 48 hours after installation, unless manufacturer's written recommendations specify longer time periods. After post-installation period, maintain a temperature of not less than 55 deg F or more than 95 deg F.
- B. Do not install products until they are at the same temperature as the space where they are to be installed.
- C. Close spaces to traffic during flooring installation and for time period after installation recommended in writing by manufacturer.
- D. Install tiles and accessories after other finishing operations, including painting, have been completed.
- E. Do not install flooring over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive, as determined by flooring manufacturer's recommended bond and moisture test.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
 - 1. Furnish not less than one box of each type, color, pattern, class, wearing surface, and size of resilient tile flooring installed.
 - 2. Deliver extra materials to Owner.

PART 2 - PRODUCTS**2.1 VINYL COMPOSITION FLOOR TILE**

- A. Vinyl Composition Floor Tile (**VCT-1**): ASTM F 1066
 - 1. Basis of Design: Armstrong Flooring; Imperial Standard Excelon
 - 2. Class: Class 2 (through-pattern tile).
 - 3. Wearing Surface: Smooth.
 - 4. Thickness: 0.125 inch.
 - 5. Size: 12 by 12 inches.
 - 6. Color: As indicated on Material Finishes Legend.

2.2 ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based formulation provided or approved by flooring manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.
- C. Floor Polish: Provide protective liquid floor polish products as recommended by manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where installation of resilient products will occur, with Installer present, for compliance with manufacturer's requirements. Verify that substrates and conditions are satisfactory for resilient product installation and comply with requirements specified.
- B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710 and the following:
 - 1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by flooring manufacturer.
 - 2. Subfloor finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" for slabs receiving resilient flooring.
 - 3. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.
- C. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with resilient product manufacturer's written installation instructions for preparing substrates indicated to receive resilient products.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, and depressions in substrates.
- C. Remove coatings, including curing compounds, and other substances that are incompatible with flooring adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
- D. Sweep and vacuum clean substrates to be covered immediately before product installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.3 TILE INSTALLATION

- A. General: Comply with tile manufacturer's written installation instructions.
- B. Lay out tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half of a tile at perimeter.
 - 1. Lay tiles square with room axis, unless otherwise indicated.

- C. Match tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Cut tiles neatly around all fixtures. Discard broken, cracked, chipped, or deformed tiles.
 - 1. Lay tiles with grain direction alternating in adjacent tiles (basket-weave pattern).
 - 2. At ramps, install tile so that joints do not occur at changes of plane in substrate.
- D. Scribe, cut, and fit tiles to butt neatly and tightly to vertical surfaces and permanent fixtures, including built-in furniture, cabinets, pipes, outlets, edgings, door frames, thresholds, and nosings.
- E. Extend tiles into toe spaces, door reveals, closets, and similar openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use chalk or other nonpermanent, nonstaining marking device.
- G. Adhere tiles to flooring substrates using a full spread of adhesive applied to substrate to comply with tile manufacturer's written instructions, including those for trowel notching, adhesive mixing, and adhesive open and working times.
 - 1. Provide completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
- H. Hand roll tiles according to tile manufacturer's written instructions.

3.4 CLEANING AND PROTECTING

- A. Comply with manufacturer's written instructions for cleaning and protecting floor tile.
- B. Perform the following operations immediately after completing floor tile installation:
 - 1. Remove adhesive and other blemishes from surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect floor tile from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Floor Polish: Remove soil, adhesive, and blemishes from floor tile surfaces before applying liquid floor polish.
 - 1. Apply three coat(s).
- E. Cover floor tile until Substantial Completion.

END OF SECTION 096519

SECTION 096520 - RESILIENT PLANK FLOORING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Luxury vinyl floor planks.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include floor plank layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
- C. Samples: Full-size units of each color and pattern required.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of floor plank to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Floor Planks: Furnish one box for every 50 boxes or fraction thereof, of each type, color, and pattern of floor planks installed.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer to perform work of this Section who has specialized in installing resilient products similar to those required for this Project and with a record of successful in-service performance.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Coordinate mockups in this Section with mockups specified in other Sections.
 - a. Size: Minimum 100 sq. ft. for each type, color, and pattern.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PROJECT CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive floor planks during the following periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer.
- C. Close spaces to traffic during flooring installation and for 48 hours after flooring installation.
- D. Install flooring after other finishing operations, including painting, have been completed.
- E. Do not install flooring over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive, as determined by flooring manufacturer's recommended bond and moisture test.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For resilient floor planks, as determined by testing identical products according to ASTM E648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

2.2 LUXURY VINYL FLOOR PLANKS

- A. Luxury Vinyl Planks (**LVT-1**): Products complying with ASTM F 1700, Class III - printed film vinyl, Type B - embossed surface.
 - 1. Basis of Design: Patcraft; Natural Slate 1533V
 - 2. Color: As indicated on Material Finishes Legend.
 - 3. Size: Nominal 8 by 59 inches.
 - 4. Thickness: 0.118 inches
 - 5. Wear Layer Thickness: 20 mil.
- B. Luxury Vinyl Planks (**LVT-2**): Products complying with ASTM F 1700, Class III - printed film vinyl, Type B - embossed surface.
 - 1. Basis of Design: Armstrong Flooring; Natural Creations, Mystix
 - 2. Color: As indicated on Material Finishes Legend.
 - 3. Size: 18 by 36 inches.
 - 4. Thickness: 0.125 inches
 - 5. Wear Layer Thickness: 20 mil.

2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by manufacturer to suit flooring and substrate conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor planks.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates: Prepare according to ASTM F 710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
 - 3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
 - 4. Moisture Testing: Perform tests recommended by floor covering manufacturer. Proceed with installation only after substrates pass testing.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install floor planks until they are same temperature as space where they are to be installed.
 - 1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
- E. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

3.3 FLOOR INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor planks.
- B. Apply leveling compound at transitions from tile to resilient flooring and feather out over two feet.
- C. Lay out floor planks from center marks established with principal walls, discounting minor offsets, so planks at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half plank at perimeter.
 - 1. Lay planks in pattern indicated, or if not indicated, install square with room axis.
- D. Match floor planks for color and pattern by selecting planks from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed planks.
 - 1. Lay planks with grain running in one direction.

- E. Scribe, cut, and fit floor planks to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- F. Extend floor planks into toe spaces, door reveals, closets, and similar openings. Extend floor planks to center of door openings.
- G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor planks as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.
- H. Adhere floor planks to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
- I. Hand roll resilient flooring according to manufacturer's written instructions.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting floor planks.
- B. Perform the following operations immediately after completing floor plank installation:
 - 1. Remove adhesive and other blemishes from surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect floor planks from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover floor planks until Substantial Completion.

END OF SECTION 096520

SECTION 096536 - STATIC-CONTROL RESILIENT FLOORING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Static-dissipative, vinyl composition floor tile.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include floor covering layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
 - 1. Show details of special patterns.
 - 2. Submit grounding diagram showing location of grounding strips and connections.
- C. Samples: For each type of static-control resilient flooring.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of static-control resilient flooring to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for floor covering installation indicated.
 - 1. Engage an installer who employs workers for this Project who are trained or certified by manufacturer for installation techniques required.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store static-control resilient flooring and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer but not less than 50 deg F or more than 90 deg F.
 - 1. Floor Tile: Store on flat surfaces.

1.7 PROJECT CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer in spaces to receive floor coverings during the following time periods:
 - 1. 48 hours before installation.
 - 2. During installation.

3. 48 hours after installation.
- B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
 - C. Close spaces to traffic during, and 48 hours after, floor covering installation.
 - D. Install floor coverings after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Static-Dissipative Properties: Provide floor coverings with static-control properties indicated as determined by testing identical products per test method indicated by an independent testing and inspecting agency.
 1. Electrical Resistance: Test per ESD-STM-7.1.
 - a. Average greater than 1 megohm and less than or equal to 1000 megohms when test specimens are tested surface to ground.
 - b. Average no less than 1 megohm and less than or equal to 1000 megohms when installed floor coverings are tested surface to ground.
 2. Static Generation: Less than 300 V when tested per AATCC-134 at 20 percent relative humidity with conductive footwear.
 3. Static Decay: 5000 to 0 V in less than 0.25 seconds when tested per FED-STD-101C/4046.1.
- B. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

2.2 STATIC-DISSIPATIVE RESILIENT FLOOR COVERINGS

- A. Static-Dissipative, Vinyl Composition Floor Tile (**VCT-2**): ASTM F 1066 (vinyl composition floor tile, nonasbestos formulated), Class 2 (through-pattern tile).
 1. Basis of Design: Armstrong; Excelon SDT
 2. Thickness: 0.125 inch.
 3. Size: 12 by 12 inches.
 4. Color: As indicated on Material Finishes Legend.

2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
- B. Static-Control Adhesive: Provided or approved by manufacturer; type that maintains electrical continuity of floor covering system to ground connection.
- C. Grounding Strips: Provided or approved by manufacturer; type and size that maintains electrical continuity of floor covering system to ground connection.

- D. Floor Polish: Provide protective, static-control liquid floor polish products recommended in writing by floor-covering manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of floor coverings and electrical continuity of floor covering systems.
- B. Concrete Substrates: Prepare according to ASTM F 710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 - 2. Remove substrate coatings and other substances that are incompatible with floor covering adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
 - 3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
 - 4. Moisture Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install floor coverings until they are same temperature as space where they are to be installed.
 - 1. Move floor coverings and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
- E. Sweep and vacuum clean substrates to be covered by floor coverings immediately before installation.

3.2 INSTALLATION, GENERAL

- A. Install static-control resilient flooring according to manufacturer's written instructions.
- B. Embed grounding strips in static-control adhesive. Extend grounding strips beyond perimeter of static-control resilient floor covering surfaces to ground connections.
- C. Scribe, cut, and fit floor coverings to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- D. Extend floor coverings into toe spaces, door reveals, closets, and similar openings. Extend floor covering to center of door openings.
- E. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor coverings as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.
- F. Install floor coverings on covers for telephone and electrical ducts, and similar items in installation areas. Maintain overall continuity of color and pattern with pieces of floor coverings installed on covers. Tightly adhere floor covering edges to substrates that abut covers and to cover perimeters.

- G. Adhere floor coverings to substrates using a full spread of static-control adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.3 FLOOR-TILE INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor tile.
- B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so floor tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half floor tile at perimeter.
 - 1. Lay floor tiles square with room axis.
- C. Match floor tiles for color and pattern by selecting floor tiles from cartons in same sequence as manufactured and packaged if so numbered. Discard broken, cracked, chipped, or deformed floor tiles.

3.4 FIELD QUALITY CONTROL

- A. Testing: Owner may engage a qualified testing agency to test electrical resistance of static-control resilient floor covering systems for compliance with requirements.
 - 1. Arrange for testing after installation static-control adhesives have fully cured and floor covering systems have stabilized to ambient conditions and after ground connections are completed.
- B. Static-control resilient flooring will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protection of flooring.
- B. Perform the following operations immediately after completing floor covering installation:
 - 1. Remove static-control adhesive and other blemishes from exposed surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect floor coverings from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
 - 1. Do not wax static-control resilient flooring.
 - 2. If recommended in writing by manufacturer, apply protective static-control floor polish formulated to maintain or enhance floor covering's electrical properties. Before polishing, do the following:
 - a. Ensure that static-control resilient flooring surfaces are free from soil, static-control adhesive, and surface blemishes.
 - b. Verify that both floor polish and its application method are approved by manufacturer and that floor polish will not leave an insulating film that reduces static-control resilient flooring's effectiveness for static control.
- D. Cover static-control resilient flooring until Substantial Completion.

END OF SECTION 096536

SECTION 096566 - RESILIENT ATHLETIC FLOORING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Rubber sheet flooring.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show installation details and locations of the following:
 - 1. Floor patterns.
 - 2. Seam locations for sheet flooring.
- C. Samples: For each exposed product and for each type, color, and pattern specified, 6-inch- square in size and of the same thickness indicated for the Work.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For resilient athletic flooring to include in maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Sheet Flooring: Furnish full-width rolls of not less than 10 linear feet for each 500 linear feet or fraction thereof, of each type, color, and pattern of flooring installed.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storing.
- B. Store materials to prevent deterioration.
 - 1. Store rolls upright.

1.6 FIELD CONDITIONS

- A. Adhesively Applied Products:
 - 1. Maintain temperatures during installation within range recommended in writing by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive flooring 48 hours before installation, during installation, and 48 hours after installation unless longer period is recommended in writing by manufacturer.
 - 2. After postinstallation period, maintain temperatures within range recommended in writing by manufacturer, but not less than 55 deg F or more than 95 deg F.

3. Close spaces to traffic during flooring installation.
 4. Close spaces to traffic for 48 hours after flooring installation unless manufacturer recommends longer period in writing.
- B. Install flooring after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 RUBBER SHEET FLOORING (**RSF-1**)

- A. Basis of Design: Tarkett; Replay
- B. Description: Rubber athletic flooring provided as rolled goods for adhered installation.
- C. Material: Recycled-rubber compound.
- D. Traffic-Surface Texture: Smooth.
- E. Roll Size: Not less than 48 inches wide by longest length that is practical to minimize splicing during installation.
- F. Thickness: 1/4 inch.
- G. Color and Pattern: As indicated on Material Finishes Legend.

2.2 ACCESSORIES

- A. Trowelable Leveling and Patching Compound: Latex-modified, hydraulic-cement-based formulation approved by flooring manufacturer.
- B. Adhesives: Water-resistant type recommended in writing by manufacturer for substrate and conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances, moisture content, and other conditions affecting performance of the Work.
 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of flooring.
- B. Concrete Substrates: Prepare according to ASTM F710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 2. Remove substrate coatings and other substances that are incompatible with floor covering adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
 3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
 4. Moisture Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
- C. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended in writing by manufacturer. Do not use solvents.
- D. Use trowelable leveling and patching compound to fill cracks, holes, and depressions in substrates.
- E. Move flooring and installation materials into spaces where they will be installed at least 48 hours in advance of installation unless manufacturer recommends a longer period in writing.
1. Do not install flooring until it is the same temperature as space where it is to be installed.
- F. Sweep and vacuum clean substrates to be covered by flooring immediately before installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, and dust. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 FLOORING INSTALLATION, GENERAL

- A. Comply with manufacturer's written installation instructions.
- B. Scribe, cut, and fit flooring to butt neatly and tightly to vertical surfaces, equipment anchors, floor outlets, and other interruptions of floor surface.
- C. Extend flooring into toe spaces, door reveals, closets, and similar openings unless otherwise indicated.
- D. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating subfloor markings on flooring. Use nonpermanent, nonstaining marking device.

3.4 SHEET FLOORING INSTALLATION

- A. Unroll sheet flooring and allow it to stabilize before cutting and fitting.
- B. Lay out sheet flooring as follows:
1. Maintain uniformity of flooring direction.
 2. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches away from parallel joints in flooring substrates.
 3. Match edges of flooring for color shading at seams.
 4. Locate seams according to approved Shop Drawings.
- C. Adhere products to substrates using a full spread of adhesive applied to substrate to comply with adhesive and flooring manufacturers' written instructions, including those for trowel notching, adhesive mixing, and adhesive open and working times.
1. Provide completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.5 CLEANING AND PROTECTION

- A. Perform the following operations immediately after completing flooring installation:
 - 1. Remove adhesive and other blemishes from flooring surfaces.
 - 2. Sweep and vacuum flooring thoroughly.
 - 3. Damp-mop flooring to remove marks and soil after time period recommended in writing by manufacturer.
- B. Protect flooring from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods recommended in writing by manufacturer.
 - 1. Do not move heavy and sharp objects directly over flooring. Protect flooring with plywood or hardboard panels to prevent damage from storing or moving objects over flooring.

END OF SECTION 096566

SECTION 096813 - TILE CARPETING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Modular carpet tile.

B. Related Requirements:

1. Section 096513 "Resilient Base and Accessories" for resilient wall base and accessories installed with carpet tile.
2. Section 096816 "Sheet Carpeting" for carpet roll goods.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to carpet tile installation including, but not limited to, the following:
 - a. Review delivery, storage, and handling procedures.
 - b. Review ambient conditions and ventilation procedures.
 - c. Review subfloor preparation procedures.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
2. Include manufacturer's written installation recommendations for each type of substrate.

B. Shop Drawings: For carpet tile installation, plans showing the following:

1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
2. Carpet tile type, color, and dye lot.
3. Type of subfloor.
4. Type of installation.
5. Pattern of installation.
6. Pattern type, location, and direction.
7. Pile direction.
8. Type, color, and location of insets and borders.
9. Type, color, and location of edge, transition, and other accessory strips.
10. Transition details to other flooring materials.

C. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.

1. Carpet Tile: Full-size Sample.
2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch- long Samples.

D. Product Schedule: For carpet tile. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.
- C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:
 - 1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
 - 2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with the Carpet and Rug Institute's CRI 104.

1.8 FIELD CONDITIONS

- A. Comply with the Carpet and Rug Institute's CRI 104 for temperature, humidity, and ventilation limitations.
- B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.
- C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.
- D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

1.9 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
 - 1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
 - 2. Failures include, but are not limited to, the following:
 - a. More than 10 percent edge raveling, snags, and runs.
 - b. Dimensional instability.

- c. Excess static discharge.
 - d. Loss of tuft-bind strength.
 - e. Loss of face fiber.
 - f. Delamination.
3. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILE

A. Carpet Tile **(CPT-1)**:

1. Basis of Design: Shaw; Noble Materials, Slab Tile 5T133.
2. Color: Forge 33518, unless otherwise indicated on Material Finishes Legend.
3. Fiber Content: 100 percent nylon 6, 6.
4. Pile Characteristic: Multi-Level Pattern Cut/Loop.
5. Density: 5778 oz./cu. yd.
6. Total Thickness: 0.310 inches.
7. Stitches: 8.0 per inch.
8. Gage: 1/10 inch.
9. Tufted Weight: 26 oz./sq. yd. for finished carpet tile.
10. Primary Backing/Backcoating: Manufacturer's standard synthetic materials.
11. Secondary Backing: Manufacturer's standard material.
12. Size: 24 by 24 inches.

B. Carpet Tile **(CPT-4)**:

1. Basis of Design: Shaw; Noble Materials, Form Tile 5T136.
2. Color: Forge Platinum 33518, unless otherwise indicated on Material Finishes Legend.
3. Fiber Content: 100 percent nylon 6, 6.
4. Pile Characteristic: Multi-Level Pattern Cut/Loop.
5. Density: 6765 oz./cu. yd.
6. Total Thickness: 0.299 inches.
7. Stitches: 8.0 per inch.
8. Gage: 1/10 inch.
9. Tufted Weight: 28 oz./sq. yd. for finished carpet tile.
10. Primary Backing/Backcoating: Manufacturer's standard synthetic materials.
11. Secondary Backing: Manufacturer's standard material.
12. Size: 24 by 24 inches.

C. Carpet Tile **(CPT-5)**:

1. Basis of Design: Shaw; Noble Materials, Alchemy Tile 5T135.
2. Color: Forge Platinum 33518, unless otherwise indicated on Material Finishes Legend.
3. Fiber Content: 100 percent nylon 6, 6.
4. Pile Characteristic: Multi-Level Pattern Cut/Loop.
5. Density: 9231 oz./cu. yd.
6. Total Thickness: 0.301 inches.
7. Stitches: 8.0 per inch.
8. Gage: 1/10 inch.
9. Tufted Weight: 30 oz./sq. yd. for finished carpet tile.
10. Primary Backing/Backcoating: Manufacturer's standard synthetic materials.
11. Secondary Backing: Manufacturer's standard material.
12. Size: 24 by 24 inches.

D. Carpet Tile (CPT-7):

1. Basis of Design: Patcraft; Artefact Patina I0511.
2. Color: Watermark 00450, unless otherwise indicated on Material Finishes Legend.
3. Fiber Content: 100 percent nylon 6, 6.
4. Pile Characteristic: Multi-Level Pattern Loop.
5. Density: 9409 oz./cu. yd.
6. Total Thickness: 0.263 inches.
7. Stitches: 9.0 per inch.
8. Gage: 1/10 inch.
9. Tufted Weight: 23 oz./sq. yd. for finished carpet tile.
10. Primary Backing/Backcoating: Manufacturer's standard synthetic materials.
11. Secondary Backing: Manufacturer's standard material.
12. Size: 12 by 48 inches.

E. Applied Treatments:

1. Soil-Resistance Treatment: Manufacturer's standard treatment.
2. Antimicrobial Treatment: Manufacturer's standard treatment that protects carpet tiles as follows:
 - a. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria, not less than 1-mm halo of inhibition for gram-negative bacteria, and no fungal growth, according to AATCC 174.

F. Performance Characteristics:

1. Appearance Retention Rating: Heavy traffic, 3.0 minimum according to ASTM D7330.
2. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm according to NFPA 253.
3. Dry Breaking Strength: Not less than 100 lbf according to ASTM D2646.
4. Delamination: Not less than 3.5 lbf/in. according to ASTM D3936.
5. Dimensional Tolerance: Within 1/32 inch of specified size dimensions, as determined by physical measurement.
6. Dimensional Stability: 0.2 percent or less according to ISO 2551 (Aachen Test).
7. Colorfastness to Crocking: Not less than 4, wet and dry, according to AATCC 165.

2.2 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation.

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.
- B. Examine carpet tile for type, color, pattern, and potential defects.

- C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.
 - 1. Moisture Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
 - a. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with the Carpet and Rug Institute's CRI 104 and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.
- C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

- A. General: Comply with the Carpet and Rug Institute's CRI 104, Section 10, "Carpet Tile," and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: As recommended in writing by carpet tile manufacturer.
- C. Maintain dye-lot integrity. Do not mix dye lots in same area.
- D. Maintain pile-direction patterns indicated on Drawings, or recommended in writing by carpet tile manufacturer.
- E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
- F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.
- H. Install pattern parallel to walls and borders.
- I. Access Flooring: Stagger joints of carpet tiles so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet adhesive; keep seams free of adhesive.

3.4 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet tile:
 - 1. Remove excess adhesive and other surface blemishes using cleaner recommended by carpet tile manufacturer.
 - 2. Remove yarns that protrude from carpet tile surface.
 - 3. Vacuum carpet tile using commercial machine with face-beater element.
- B. Protect installed carpet tile to comply with the Carpet and Rug Institute's CRI 104, Section 13.7.
- C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 096813

SECTION 096816 - SHEET CARPETING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Tufted carpet.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to carpet installation including, but not limited to, the following:
 - a. Review delivery, storage, and handling procedures.
 - b. Review ambient conditions and ventilation procedures.
 - c. Review subfloor preparation procedures.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacturer's written data on physical characteristics and durability.
2. Include manufacturer's written installation recommendations for each type of substrate.

B. Shop Drawings: For carpet installation, showing the following:

1. Columns, doorways, enclosing walls or partitions and locations where cutouts are required in carpet.
2. Carpet type, color, and dye lot.
3. Locations where dye lot changes occur.
4. Seam locations, types, and methods.
5. Type of subfloor.
6. Type of installation.
7. Pattern type, repeat size, location, direction, and starting point.
8. Pile direction.
9. Types, colors, and locations of edge, transition, and other accessory strips.
10. Transition details to other flooring materials.

C. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.

1. Carpet: 12-inch- square Sample.
2. Carpet Seam: 6-inch Sample.

D. Product Schedule: For carpet. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

- B. Product Test Reports: For carpet, for tests performed by a qualified testing agency.
- C. Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For carpet to include in maintenance manuals. Include the following:
 - 1. Methods for maintaining carpet, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
 - 2. Precautions for cleaning materials and methods that could be detrimental to carpet.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Carpet: Full-width rolls equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is certified by the Floor Covering Installation Board or who can demonstrate compliance with its certification program requirements.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 - 1. Build mockups at locations and in sizes shown on Drawings.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Comply with the Carpet and Rug Institute's CRI 104.
- B. Deliver carpet in original mill protective covering with mill register numbers and tags attached.

1.9 FIELD CONDITIONS

- A. Comply with the Carpet and Rug Institute's CRI 104 for temperature, humidity, and ventilation limitations.
- B. Environmental Limitations: Do not deliver or install carpet until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.
- C. Do not install carpet over concrete slabs until slabs have cured, are sufficiently dry to bond with adhesive, and have pH range recommended by carpet manufacturer.

1.10 WARRANTY

- A. Special Warranty for Carpet: Manufacturer agrees to repair or replace components of carpet installation that fail in materials or workmanship within specified warranty period.
1. Warranty does not include deterioration or failure of carpet due to unusual traffic, failure of substrate, vandalism, or abuse.
 2. Failures include, but are not limited to, the following:
 - a. More than 10 percent loss of face fiber, edge raveling, snags, and runs.
 - b. Loss of tuft bind strength.
 - c. Excess static discharge.
 - d. Delamination.
 3. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TUFTED CARPET (**CPT-3**)

- A. Basis of Design: Bentley; Outlier
- B. Color: As indicated on Finish Legend.
- C. Fiber Content: 100 percent nylon 6, 6.
- D. Pile Characteristic: Tufted textured loop pile.
- E. Density: 7,582 oz./cu. yd.
- F. Pile Height: 0.146 inch.
1. Coordinate pile height with nosing height.
- G. Stitches: 11.0 per inch.
- H. Gauge: 1/10 per inch.
- I. Total Weight: 81 oz./sq. yd.
- J. Backing: High performance backing consisting of polyester, polypropylene, and conductive latex or any combination thereof.
- K. Roll Width: 12 feet.
- L. Applied Treatments:
1. Applied Soil-Resistance Treatment: Manufacturer's standard material.
 2. Antimicrobial Treatment: Manufacturer's standard material.

2.2 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet manufacturer.

- B. Adhesives: Water-resistant, mildew-resistant, nonstaining type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet and is recommended or provided by carpet manufacturer.
- C. Seam Adhesive: Hot-melt adhesive tape or similar product recommended by carpet manufacturer for sealing and taping seams and butting cut edges at backing to form secure seams and to prevent pile loss at seams.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet performance.
- B. Examine carpet for type, color, pattern, and potential defects.
- C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits. Verify that slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond.
 - 1. Moisture Testing: Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet manufacturer.
 - a. Perform additional moisture tests recommended in writing by adhesive and carpet manufacturers. Proceed with installation only after substrates pass testing.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with the Carpet and Rug Institute's CRI 104 and with carpet manufacturer's written installation instructions for preparing substrates.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch, unless more stringent requirements are required by manufacturer's written instructions.
- C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet manufacturers.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet.

3.3 INSTALLATION

- A. Comply with the Carpet and Rug Institute's CRI 104 and carpet manufacturer's written installation instructions for the following:
 - 1. Stair installation.

- B. Comply with carpet manufacturer's written instructions and Shop Drawings for seam locations and direction of carpet; maintain uniformity of carpet direction and lay of pile. At doorways, center seams under the door in closed position.
- C. Install pattern parallel to walls.
- D. Do not bridge building expansion joints with carpet.
- E. Cut and fit carpet to butt tightly to vertical surfaces, permanent fixtures, and pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet manufacturer.
- F. Extend carpet into toe spaces, door reveals, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet as marked on subfloor. Use nonpermanent, nonstaining marking device.

3.4 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet:
 - 1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet manufacturer.
 - 2. Remove yarns that protrude from carpet surface.
 - 3. Vacuum carpet using commercial machine with face-beater element.
- B. Protect installed carpet to comply with the Carpet and Rug Institute's CRI 104.
- C. Protect carpet against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods recommended in writing by carpet manufacturer and carpet adhesive manufacturer.

END OF SECTION 096816

SECTION 096933 - LOW-PROFILE FIXED HEIGHT ACCESS FLOORING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes low-profile, fixed-height access flooring.

1.2 COORDINATION

- A. Coordinate location of electrical work in underfloor cavity and wire management channels.
- B. Coordinate floor covering finish with adaptive cabling distribution access flooring.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review connections between low-profile, fixed-height access flooring and electrical systems.
- B. Sequencing: Install access flooring when ceiling work is complete, and interior walls are constructed and finish painted.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for low-profile, fixed-height access flooring.
 - 2. Include loading capacities.
- B. Shop Drawings: For low-profile, fixed-height access flooring:
 - 1. Include layout of low-profile, fixed-height access flooring and relationship to adjoining Work based on field-verified dimensions.
 - 2. Details and sections with descriptive notes indicating materials, finishes, fasteners, typical and special edge conditions, accessories, and understructures.
- C. Samples: One full-size unit for each base unit, half-base unit, and channel plate of adaptive cabling distribution access flooring required.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Low-Profile, Fixed-Height Access-Flooring Components: Two percent of adaptive cabling distribution access flooring.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Build mockup of typical low-profile, fixed-height access flooring, as shown on Drawings. Size to be an area of no fewer than five floor panels in length by five floor panels in width.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Low-profile, fixed-height access flooring shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Structural Performance:
 - 1. Loading Capacity: 100-lbf/sq. ft. live load with the following deflection and permanent set:
 - a. Top-Surface Deflection: Maximum 0.15 inch.
 - b. Permanent Set: Maximum 0.06 inch.
- C. Fire Performance:
 - 1. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 75 or less.

2.2 ADAPTIVE CABLING DISTRIBUTION ACCESS FLOORING WITH MODULAR WIRING SYSTEM

- A. Adaptive Cabling Distribution Access Flooring with Modular Wiring: Manufacturer's standard, modular, steel or polymer components, designed to interconnect and provide channels for installation of wiring. Include factory-assembled modular wiring harnesses and service outlets.
 - 1. Basis of Design: FreeAxez LLC; Gridd 40, 1.6-inch Access Flooring System
 - 2. Module: Adaptive cabling distribution access flooring with nominal module size of 19.625 by 19.625 inches.
 - 3. Height: Provide adaptive cabling distribution access flooring with nominal height of 2.75 inches.
- B. Modular Power Components: Manufactured Wiring System consisting of 50-A power tracks, tap-off whips, floor-box service outlets, desk mounted service outlets, and wired furniture power interface enclosures.
 - 1. Wiring Method, Track-Feed Modules - Three Phase: MC cable, containing insulated 4 AWG, 6 AWG, and 8 AWG insulated-stranded-copper conductors.
 - 2. Wiring Method, Modular Power Components: Flexible metal conduit, containing three insulated 10 or 12 AWG solid- or stranded-copper conductors.

- C. Service Outlets and Wiring: Standard listed and labeled assemblies, for recessed mounting flush with top of floor panels; for power, communication, and signal services; and complying with the following requirements:
1. Structural Performance: Cover capable of supporting a 300-lbf concentrated load.
 2. Cover and Box Type: Hinged steel cover with opening for passage of cables when cover is closed and including frame and steel box or formed-steel plate for mounting electrical receptacles, communication jacks, and signal jacks[with factory-installed fitting]. Box supplied with factory-installed whip and track connector.
 3. Receptacles and Wiring: Equip each service outlet with power receptacles to comply with the following requirements:
 - a. Type of Receptacle: Heavy-duty simplex, two-pole, three-wire grounding, 20 A, 125 V, NEMA WD 6, Configuration 5-20R unless otherwise indicated.
 - b. Number of Receptacles for Outlet: Four or Five
 - c. Wiring Method: Factory wired for field hardwiring with flexible metal conduit, containing three or four insulated 10 or 12 AWG solid- or stranded-copper conductors
 4. Overcurrent Protection: Equip each service outlet with single or two pole, 20A, 125/250V circuit breakers to suit Project.
- D. Desk Mounted Service Outlets and Wiring: Standard listed and labeled assemblies for mounting to desks or millwork; for power, communication, and signal services; and complying with the following requirements:
1. Box Type: Steel box plate for mounting electrical receptacles, communication jacks, and signal jacks. Box supplied with factory-installed whip and track connector.
 2. Receptacles and Wiring: Equip each service outlet with power receptacles. Requirements to be determined.
 3. Overcurrent Protection: Equip each service outlet with one or two pole, 20A, 125/250 V circuit breakers to suit Project.
- E. Circuit Breaker Box for Power-Interface with Furniture and Wall Receptacle Power: Standard listed and labeled assemblies for mounting flush with the top of floor components for powering wired furniture and complying with the following requirements:
1. Structural Performance: Cover capable of supporting a 300-lbf concentrated load.
 2. Cover and Box Type: Hinged steel cover. Box supplied with factory-installed whip and track connector.
 3. Wiring Method, Modular Power Components: Flexible metal conduit, containing three or four insulated 10 or 10 AWG solid- or stranded-copper conductors with factory-installed quick-connect fitting.
 4. Overcurrent Protection: Equip each service outlet with three single pole, 20A, 125/250 V circuit breakers to suit Project.
- F. Wiring Accessories:
1. Grommet with twist-close cover.
 2. Underfloor electrical junction box for connection of branch circuit and feeder wiring.
 3. Cable management boots and sleeves to support transition of cables to adaptive cable distribution access floor.
 4. Quick-connect fitting.
- G. Fascia Closures: Where underfloor cavity is not enclosed by abutting walls or other construction, provide stainless steel closure assembly. Provide galvanized-steel frame-anchor component.

- H. Ramps: Manufacturer's standard ramp construction of width and slope indicated, but not steeper than 1:12, of same materials, performance, and construction requirements as adaptive cabling distribution access flooring.
- I. Border Components: Provide manufacturer's standard method for filling gaps between adaptive cabling distribution flooring and edge conditions.
- J. Undersheet: Manufacturer's standard.

2.3 FABRICATION

- A. Fabrication Tolerances:
 - 1. Size: Plus or minus 0.020 inch of required size.
 - 2. Flatness: Plus or minus 0.035 inch, measured on a diagonal on top of panel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer and manufacturer's authorized representative present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Verify that substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of conditions and deleterious substances that might interfere with attachment of pedestals.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- B. Lay out low-profile access flooring installation to keep the number of cut panels at floor perimeter to a minimum. Avoid using panels cut to less than 6 inches.
- C. Complete any necessary subfloor preparation, and vacuum subfloor to remove dust, dirt, and construction debris before beginning installation.

3.3 INSTALLATION

- A. Install low-profile, fixed-height access flooring and accessories under supervision of low-profile, fixed-height access-flooring manufacturer's authorized representative to produce a rigid, firm installation that complies with performance requirements and is free of instability, rocking, rattles, and squeaks.
- B. Install flooring securely in place and properly seated, with panel edges flush. Do not force panels into place.
- C. Scribe perimeter panels to provide a close fit with adjoining construction, having no voids greater than 1/8 inch where panels abut vertical surfaces.

3.4 PROTECTION

- A. Protect installation from work of other trades until date of Substantial Completion.
- B. As installation progresses, maintain access-flooring installation areas broom clean.
- C. Control traffic across access flooring during installation to ensure floor capacity is not exceeded.

END OF SECTION 096933

SECTION 097200 - WALL COVERINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Wood-veneer wall covering.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include data on physical characteristics, durability, fade resistance, and fire-test-response characteristics.
- B. Shop Drawings: Show location and extent of each wall-covering type. Indicate veneer matching seams and termination points. Coordinate breakpoints with manufacturer.
- C. Samples: For each type of wall covering and for each color, pattern, texture, and finish specified, full width by 36 inches long in size.
 - 1. Wood-Veneer Wall-Covering Sample: From same flitch to be used for the Work, with specified finish applied.
- D. Product Schedule: For wall coverings. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each wall covering, for tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For wall coverings to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for installation.
 - 1. Build mockups for each type of wall covering on each substrate required. Comply with requirements in ASTM F1141 for appearance shading characteristics.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install wall coverings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and HVAC system is operating and maintaining ambient temperature and humidity conditions at levels intended for occupants after Project completion during the remainder of the construction period.
 - 1. Wood-Veneer Wall Coverings: Condition spaces for not less than 48 hours before installation.
- B. Lighting: Do not install wall covering until lighting that matches conditions intended for occupants after Project completion is provided on the surfaces to receive wall covering.
- C. Ventilation: Provide continuous ventilation during installation and for not less than the time recommended by wall-covering manufacturer for full drying or curing.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: As determined by testing identical wall coverings applied with identical adhesives to substrates in accordance with test method indicated below by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 15 or less.
 - b. Smoke-Developed Index: 25 or less.

2.2 WOOD-VENEER WALL COVERING (**WCV-1**)

- A. Basis of Design: Wolf Gordon; WonderWood WWDF 217
- B. Description: Provide wood-veneer wall covering in rolls from same production run and from same flitch. Ship wall coverings rolled in boxes.
- C. Sheet Size: 24 by 96 inches.
- D. Veneer Construction: Single-ply veneer.
- E. Wood Species: European Walnut.
- F. Cut: Quartered.
- G. Veneer Match: Slip.
- H. Sheet Match: Balance.
- I. Applied Backing Material: Manufacturer's standard.
- J. Finish: Factory applied using wall-covering manufacturer's standard stain and polyurethane system.
 - 1. Colors: As selected by Architect from manufacturer's full range.

2.3 ACCESSORIES

- A. Adhesive: Mildew-resistant, nonstaining adhesive, for use with specific wall covering and substrate application indicated and as recommended in writing by wall-covering manufacturer.
- B. Primer/Sealer: Mildew resistant, complying with requirements in Section 099123 "Interior Painting" and recommended in writing by primer/sealer and wall-covering manufacturers for intended substrate.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation surfaces being true in plane and vertical and horizontal alignment, maximum moisture content, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions for surface preparation.
- B. Clean substrates of substances that could impair bond of wall covering, including dirt, oil, grease, mold, and mildew.
- C. Prepare substrates to achieve a smooth, dry, clean, structurally sound surface free of flaking, unsound coatings, cracks, and defects.
 - 1. Gypsum Board: Apply primer/sealer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
- D. Remove hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.
- E. Acclimatize wall-covering materials by removing them from packaging in the installation areas not less than 24 hours before installation.

3.3 CLEANING

- A. Remove excess adhesive at seams, perimeter edges, and adjacent surfaces.
- B. Use cleaning methods recommended in writing by wall-covering manufacturer.
- C. Replace strips that cannot be cleaned.
- D. Reinstall hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

END OF SECTION 097200

SECTION 098433 - SOUND-ABSORBING WALL UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Section includes shop-fabricated, acoustical panel units tested for acoustical performance, including the following:
 - 1. Sound-absorbing wall panels.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include panel edge, core material, and mounting indicated.
- B. Shop Drawings: For unit assembly and installation.
 - 1. Include plans, elevations, sections, and mounting devices and details.
 - 2. Include details at panel head, base, joints, and corners; and details at ceiling, floor base, and wall intersections. Indicate panel edge profile and core materials.
 - 3. Include details at cutouts and penetrations for other work.
- C. Samples: For each finish product specified, two samples, minimum size 12 inches square, representing actual product, color, and patterns.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Elevations and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Electrical outlets, switches, and thermostats.
 - 2. Items penetrating or covered by units including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Alarms.
 - e. Sprinklers.
 - f. Access panels.
 - 3. Show operation of hinged and sliding components covered by or adjacent to units.
- B. Product Certificates: For each type of unit.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of unit to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer Qualifications: Minimum 2 years documented experience installing projects of similar size and complexity.
- C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
 - 1. Finish areas designated by Architect.
 - 2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
 - 3. Refinish mock-up area as required to produce acceptable work.
 - 4. Accepted mock-ups shall be comparison standard for remaining Work

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver material in the manufacturer's original, unopened, undamaged containers with identification labels intact.
- B. Store products off the floor in manufacturer's unopened packaging protected from exposure to harmful environmental conditions and at temperature and humidity conditions as recommended by the manufacturer.
- C. A minimum of 72 hours prior to installation, wood products shall be stored in the room in which they will be installed. Temperature and humidity of the room during this period shall closely approximate those conditions that will exist when the building is occupied.
- D. Handle materials to avoid damage.

1.8 SEQUENCING

- A. Ensure that locating templates and other information required for installation of products of this section are furnished to affected trades in time to prevent interruption of construction progress.
- B. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

1.9 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
- B. Space shall be fully enclosed with all exterior windows and doors in place, glazed, and weather-stripped. Roof is to be watertight, and all wet trades' work is to be completed, and thoroughly dry.
- C. Install only when the temperature and humidity closely approximate the interior conditions that will exist when the building is occupied. Heating and cooling systems shall be operating before, during, and after installation, with the humidity of the interior spaces maintained between 25 and 55 percent, and a temperature between 60 to 90 degrees F.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire Performance Characteristics: Wall units shall conform to Class 1, or A flame spread rating, tested according to ASTM E 84; Flame Spread: 25 or less. Smoke Developed: 450 or less.

2.2 MATERIALS - GENERAL

- A. Wood is a natural product that will undergo changes with variations in the environment. Therefore, all dimensional tolerances are plus or minus 1/8 inch.

2.3 PANEL GRILLE PANELS (WWP-1)

- A. General: Standard Panel Grilles are 1 foot wide and in nominal lengths of 2 feet to 10 feet in 1-inch increments. Actual lengths are 1 inch shorter to allow for a reveal between panels. Wood strips are fabricated without finger-joints, and fastened together with black dowels or woodbackers, depending on panel design. Dowels or woodbackers are positioned 5-1/2 inches from the ends and 12 inches on center, with interconnecting male-to-female dowel attachment or with overlapping woodbackers, depending on panel design for support of the system.

1. Basis of Design: Rulon; Panel Grille
2. Profiles: Panel Size: As indicated on the Drawings
3. Size:

- a. Number of Blades per foot: _____
- b. Blade Thickness: _____
- c. Depth of the Blades: _____

4. Panel Design Description:

- a. Doweled Panel Grilles: Grilles consist of individual wood strips assembled in 12 inch widths in lengths up to 10 feet. Wood strips are drilled 12 inches on center, beginning 5-1/2 inch from each end. Dowels are positioned perpendicular to the wood strips. Panel Grilles are 1 inch under an even foot length. Dowels are generally furnished black to be hidden from view. Dowel clips are used to snap the Panel Grilles into place.
- b. Wood-backed Panel Grilles: Grilles consist of individual wood strips assembled in 12 inch widths in lengths up to 10 feet. Woodbackers are attached to the back of grilles 12 inches on center, beginning 5-1/2 inch from each end. Woodbackers are positioned perpendicular to the wood strips. Panel Grilles are 1 inch under an even foot length. Woodbackers are generally furnished black to be hidden from view. Woodbacker clips are used to snap the Panel Grilles into place.
- c. Doweled and wood-backed Panel Grilles: Grilles consist of individual wood strips assembled in 12 inch widths in lengths up to 10 feet. Wood strips are drilled 12 inches on center, beginning 5-1/2 inch from each end. Woodbackers are attached to the back of grilles 12 inches on center, beginning 5-1/2 inch from each end. Dowels and woodbackers are positioned perpendicular to the wood strips. Panel Grilles are 1 inch under an even foot length. Dowels and woodbackers are generally furnished black to be hidden from view. Woodbacker clips are used to snap the Panel Grilles into place.

5. Blade Design:

- a. B Bullnose Blade
- b. S Slanted Blade

6. Trim and Border Treatment: Provide end caps or junction trims as indicated on the Drawings in the same species and finish as the Panel Grille.

7. Wood Species: To be determined.
8. Finish: To be determined.

2.4 ACCESSORIES

- A. Mounting Devices: Concealed on back of unit, recommended by manufacturer to support weight of unit, and as follows:
 1. Metal Clips or Bar Hangers: Manufacturer's standard two-part metal "Z" clips, with one part of each clip mechanically attached to back of unit and the other part to substrate, designed to permit unit removal.

2.5 FABRICATION

- A. Edges, borders, and perimeter trims shall be indicated on the Drawings in accordance with the manufacturer's standard design details.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fabricated units, substrates, areas, and conditions for compliance with requirements, installation tolerances, and other conditions affecting unit performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Work shall not begin until the space is fully enclosed and glazed and all wet work is completed and dried out to the satisfaction manufacturer.
- C. Temperature shall be at least 65 degrees Fahrenheit during the installation and thereafter.
- D. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

- A. Install units in locations indicated. Unless otherwise indicated, install units with vertical surfaces and edges plumb, top edges level and in alignment with other units, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.
- B. Comply with manufacturer's written instructions for installation of units using type of mounting devices indicated. Mount units securely to supporting substrate.

3.4 FIELD QUALITY CONTROL

- A. Technical Service: Manufacturer shall provide a local Technical Service Representative for on-site training and assistance during the installation process.

- B. Environmental Monitoring: Manufacturer shall provide a temperature and humidity sensor to actively monitor the room in which the wood slats shall be installed for a minimum of one week before and up to two weeks after installation has been completed including all of the weeks in between.
- C. Upon completion of installation, the owner's representative shall inspect all finished surfaces to ensure that the work has been completed in a manner satisfactory to the owner. Any deficiencies in the installation shall be corrected prior to substantial completion.

3.5 ADJUSTMENTS AND CLEANING

- A. Clean exposed surfaces of panels in accordance with manufacturer's instructions.
- B. Remove and replace panels and tiles, which cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

3.6 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 098433

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Primers.
 2. Water-based finish coatings.
 3. Floor sealers.
 4. Dry fall coatings.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
1. Include preparation requirements and application instructions.
 2. Indicate VOC content.
- B. Samples: For each type of topcoat product.
- C. Samples for Verification: For each type of paint system and each color and gloss of topcoat.
1. Submit Samples on rigid backing, 8 inches square.
 2. Apply coats on Samples in steps to show each coat required for system.
 3. Label each coat of each Sample.
 4. Label each Sample for location and application area.
- D. Product Schedule: Use same designations indicated on Drawings and in the Interior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

1.3 CLOSEOUT SUBMITTALS

- A. Mix Formula: For each color provided.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Paint Products: 5 percent, but not less than 1 gal. of each material and color applied.

1.5 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Architect will select one surface to represent surfaces and conditions for application of each paint system.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft.
 - b. Other Items: Architect will designate items or areas required.

2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 1. Maintain containers in clean condition, free of foreign materials and residue.
 2. Remove rags and waste from storage areas daily.

1.7 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures of less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Benjamin Moore
 2. PPG
 3. Sherwin-Williams
- B. Source Limitations: Obtain each paint product from single source from single manufacturer.

2.2 PAINT PRODUCTS, GENERAL

- A. Material Compatibility:
 1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- B. Colors: As selected by Architect from manufacturer's full range.

2.3 PRIMERS

- A. Interior, Institutional Low-Odor/VOC Primer Sealer: Water-based primer sealer with low-odor characteristics and a VOC of less than 10 grams per liter for use on new interior plaster, concrete, and gypsum wallboard surfaces that are subsequently to be painted with latex finish coats.
1. Benjamin Moore; Ultra Spec Zero VOC Primer, 534
 2. PPG; Speedhide Interior Zero VOC Latex Sealer, 6-4900XI
 3. Sherwin-Williams; ProMar 200 Zero Interior Latex Primer, B28W02600
- B. Wood-Knot Sealer: White shellac or other sealer recommended in writing by manufacturer for this purpose.
- C. Interior Latex Primer for Wood: Waterborne-emulsion primer formulated for resistance to extractive bleeding, mold, and microbes; for hiding stains; and for use on interior wood subject to extractive bleeding.
1. Benjamin Moore; Seal Lock Plus Primer/Sealer, IL-6800
 2. PPG; Seal Grip Int/Ext Stain Blocking Primer, 17-921
 3. Sherwin-Williams; Synthetic Shellac, B49W60
- D. Water-Based Rust-Inhibitive Primer: Corrosion-resistant, water-based-emulsion primer formulated for resistance to flash rusting when applied to cleaned, interior ferrous metals subject to mildly corrosive environments.
1. Benjamin Moore; Acrylic Metal Primer, M04
 2. PPG; Pitt-Tech Plus Int/Ext DTM Industrial Primer, 90-912
 3. Sherwin-Williams; Pro-Industrial Pro-Cryl Universal Primer, B66W310
- E. Water-Based Galvanized-Metal Primer: Corrosion-resistant, acrylic primer; formulated for use on cleaned/etched, exterior, galvanized metal to prepare it for subsequent water-based coatings.
1. Benjamin Moore; Super Spec HP Acrylic Metal Primer, P04
 2. PPG; Pitt-Tech Plus Int/Ext DTM Industrial Primer, 90-912
 3. Sherwin-Williams; Pro Industrial Pro-Cryl Universal Primer, B66W310

2.4 WATER-BASED FINISH COATS

- A. Interior, Latex, Institutional Low Odor/VOC, Flat: White or colored latex paint with low-odor characteristics and a VOC of less than 10 grams per liter, for use in areas, such as hospitals and other occupied buildings, where the odor and VOC levels of conventional latex products would preclude their use.
1. Benjamin Moore; Ultra Spec Zero VOC Flat, 536
 2. PPG; Speedhide Zero Interior Zero-VOC Latex Flat 6-4110XI
 3. Sherwin-Williams; ProMar 200 Zero VOC Flat, B30W2600 Series
- B. Interior, Latex, Institutional Low Odor/VOC, Low Sheen: White or colored latex paint with low-odor characteristics and a VOC of less than 10 grams per liter, for use in areas, such as hospitals and other occupied buildings, where the odor and VOC levels of conventional latex products would preclude their use.
1. Benjamin Moore; Ultra Spec Zero VOC Low Sheen, 537
 2. PPG; Speedhide Zero Interior Zero-VOC Latex Eggshell 6-4310XI
 3. Sherwin-Williams; ProMar 200 Eg-Shel Latex, B20W2600 Series

- C. Interior, Latex, Institutional Low Odor/VOC, Semigloss: White or colored latex paint with low-odor characteristics and a VOC of less than 10 grams per liter, for use in areas, such as hospitals and other occupied buildings, where the odor and VOC levels of conventional latex products would preclude their use.
1. Benjamin Moore; Ultra Spec Zero VOC Semi-Gloss, 539
 2. PPG; Speedhide Zero Interior Zero-VOC Latex Semi-Gloss 6-4510XI
 3. Sherwin-Williams; ProMar 200 Zero VOC Interior Latex Semi-Gloss, B31W2600 Series

2.5 FLOOR SEALERS

- A. Water-Based Concrete Floor Sealer: Clear, water-based, acrylic-copolymer-emulsion sealer formulated for oil, gasoline, alkali, and water resistance and for use on concrete traffic surfaces.
1. Benjamin Moore; Concrete Waterproofing Sealer, 075
 2. PPG; Porter Plex-Seal W.B. Sealer 3215
 3. Sherwin-Williams; H & C Concrete & Masonry Waterproofing Sealer 50.043054

2.6 DRY FALL COATINGS

- A. Water Based, Dry Fall for Galvanized Steel, Flat: Pigmented, water-based coating for direct application to cleaned, interior galvanized-metal ceiling surfaces and adjacent primed metals.
1. Benjamin Moore; Latex Flat Dry Fall, 395
 2. PPG; Speedhide Super Tech Dryfall Primer and Finish, DP318XX
 3. Sherwin-Williams; Pro Industrial Waterborne Acrylic Dryfall, B42W00181

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
1. Concrete: 12 percent.
 2. Wood: 15 percent.
 3. Gypsum Board: 12 percent.
- C. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- D. Proceed with coating application only after unsatisfactory conditions have been corrected.
1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- F. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer.
- G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- I. Wood Substrates:
 1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
 2. Sand surfaces that will be exposed to view, and dust off.
 3. Prime edges, ends, faces, undersides, and backsides of wood.
 4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

3.3 INSTALLATION

- A. Apply paints according to manufacturer's written instructions.
 1. Use applicators and techniques suited for paint and substrate indicated.
 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Painting Fire-Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
1. Paint the following work where exposed in equipment rooms:
 - a. Equipment, including panelboards and switch gear.
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Tanks that do not have factory-applied final finishes.
 - h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 2. Paint the following work where exposed in occupied spaces:
 - a. Equipment, including panelboards.
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 - h. Other items as directed by Architect.
 3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 MARKING AND IDENTIFICATION

- A. Fire walls, fire barriers, fire partitions, smoke barriers and smoke partitions or any other wall required to have protected openings or penetrations shall be effectively and permanently identified with signs or stenciling. Such identification shall:
1. Be located in accessible concealed floor, floor-ceiling or attic spaces; and
 2. Be repeated at intervals not exceeding 20 feet measured horizontally along both sides of the wall or partition; and
 3. Include red lettering not less than 2 inches in height, incorporating the suggested wording: "X HOUR FIRE AND/OR SMOKE BARRIER-PROTECT ALL OPENINGS," or other wording approved or required by Authority Having Jurisdiction (AHJ). Replace "X" with the appropriate designated hourly rating.
 4. Apply a minimum one-inch wide bright red horizontal line, both sides of wall, interrupted for approved text, at the required interval.
 5. Refer to the Drawings for locations of walls and for applicable types and ratings.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
1. Do not clean equipment with free-draining water and prevent solvents, thinners, cleaners, and other contaminants from entering into waterways, sanitary and storm drain systems, and ground.

2. Dispose of contaminants in accordance with requirements of authorities having jurisdiction.
 3. Allow empty paint cans to dry before disposal.
 4. Collect waste paint by type and deliver to recycling or collection facility.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

A. Concrete Substrates, Traffic Surfaces:

1. Water-Based Concrete Floor Sealer System:
 - a. First Coat: Matching topcoat.
 - b. Topcoat: Water-based concrete floor sealer.

B. Steel Substrates:

1. Institutional Low-Odor/VOC Latex System:
 - a. Prime Coat: Water-based rust-inhibitive primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, institutional low odor/VOC, semigloss.
2. Water-Based Dry-Fall System:
 - a. Prime Coat: Shop primer specified in Section where substrate is specified.
 - b. Topcoat: Dry fall, latex, flat.

C. Galvanized-Metal Substrates:

1. Institutional Low-Odor/VOC Latex System:
 - a. Prime Coat: Water-based galvanized primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, institutional low odor/VOC, semigloss.
2. Water-Based Dry-Fall System:
 - a. Prime Coat: Matching topcoat.
 - b. Topcoat: Water-based dry fall for galvanized steel, flat.

D. Wood Substrates:

1. Institutional Low-Odor/VOC Latex System:
 - a. Prime Coat: Interior latex primer for wood.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex, institutional low odor/VOC, semigloss.

E. Gypsum Board Substrates:

1. Institutional Low-Odor/VOC Latex System:

- a. Prime Coat: Interior, institutional low-odor/VOC primer sealer.
- b. Intermediate Coat: Matching topcoat.
- c. Topcoat for Ceilings: Interior, latex, institutional low odor/VOC, flat.
- d. Topcoat for Walls: Interior, latex, institutional low odor/VOC, low sheen.

END OF SECTION 099123

SECTION 102113.16 - PLASTIC-LAMINATE-CLAD TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plastic-laminate-clad toilet compartments configured as toilet enclosures and urinal screens.

B. Related Requirements:

1. Section 102800 "Toilet and Bath Accessories" for toilet tissue dispensers, grab bars, and similar accessories mounted on toilet compartments.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for toilet compartments.

B. Shop Drawings: For toilet compartments.

1. Include plans, elevations, sections, details, and attachment details.
2. Show locations of cutouts for compartment-mounted toilet accessories.
3. Show locations of centerlines of toilet fixtures.
4. Show locations of floor drains.
5. Show overhead support or bracing locations.

C. Samples: For each type of material, color, and finish required for toilet compartments.

D. Product Schedule: For toilet compartments, prepared by or under the supervision of supplier, detailing location and selected colors for toilet compartment material.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of toilet compartment.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For toilet compartments to include in maintenance manuals.

1.5 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 450 or less.
- B. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for toilet compartments designated as accessible.

2.2 PLASTIC-LAMINATE-CLAD TOILET COMPARTMENTS

- A. Manufacturers: Subject to compliance with requirements, provide products from one of the following:
 - 1. ASI Accurate Partitions; ASI Group.
 - 2. ASI Global Partitions; ASI Group.
 - 3. Bobrick Washroom Equipment.
 - 4. Bradley Corp.
 - 5. General Partitions Mfg. Corp.
 - 6. Hadrian Manufacturing Inc.
 - 7. Hiny Hiders; Division of Scranton Products
 - 8. Partition Systems Incorporated of South Carolina
- B. Toilet-Enclosure Style: Overhead braced/floor anchored.
- C. Urinal-Screen Style: Floor anchored.
- D. Door, Panel, and Pilaster Construction: One-piece, plastic-laminate facing sheets pressure laminated to core material without splices or joints in facings or cores; with laminate applied to edges before faces to seal edges and prevent laminate from being pried loose. Seal exposed core material at cutouts to protect core from moisture.
 - 1. Core Material: Particleboard.
 - 2. Doors and Panels: Finished to not less than 1 inch thick.
 - 3. Pilasters: Finished to not less than 1 inch thick and with internal, nominal 0.120-inch-thick, steel-sheet reinforcement.
- E. Pilaster Shoes: Formed from stainless steel sheet, not less than 0.031-inch nominal thickness and 3 inches high, finished to match hardware.
- F. Urinal-Screen Post: Manufacturer's standard post design of material matching the thickness and construction of pilasters; with shoe matching that on the pilaster.
- G. Brackets (Fittings):
 - 1. Stirrup Type: Ear or U-brackets, stainless steel.
- H. Plastic-Laminate Finish (**TPT-1**):
 - 1. Color and Pattern: As indicated on Material Finishes Legend.

2.3 HARDWARE AND ACCESSORIES

- A. Hardware and Accessories: Manufacturer's standard design, heavy-duty operating hardware and accessories.
 - 1. Material: Stainless steel.
 - 2. Hinges: Manufacturer's premium grade paired, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees, allowing emergency access by lifting door.
 - 3. Latch and Keeper: Manufacturer's premium grade surface-mounted latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
 - 4. Coat Hook: Manufacturer's premium grade combination hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories.
 - 5. Door Bumper: Manufacturer's premium grade rubber-tipped bumper at out-swinging doors.
 - 6. Door Pull: Manufacturer's premium grade unit at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible.
- B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.
- C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized-steel, or other rust-resistant, protective-coated steel anchors compatible with related materials.

2.4 MATERIALS

- A. Particleboard: ANSI A208.1, Grade M-2.
- B. Plastic Laminate: NEMA LD 3, general-purpose HGS grade, 0.048-inch nominal thickness.
- C. Aluminum Extrusions: ASTM B221.
- D. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, stretcher-leveled standard of flatness.
- E. Stainless Steel Castings: ASTM A743/A743M.

2.5 FABRICATION

- A. Fabrication, General: Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories where required for attachment of toilet accessories.
- B. Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.
- C. Floor-Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.

- D. Urinal-Screen Posts: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at bottoms of posts. Provide shoes at posts to conceal anchorage.
- E. Door Size and Swings: Unless otherwise indicated, provide 24-inch- wide in-swinging doors for standard toilet compartments and 36-inch- wide out-swinging doors with a minimum 32-inch- wide clear opening for compartments designated as accessible.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the Work.
 - 1. Confirm location and adequacy of blocking and supports required for installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.
 - 1. Maximum Clearances:
 - a. Pilasters and Panels: 1/2 inch.
 - b. Panels and Walls: 1 inch.
 - 2. Stirrup Brackets: Secure panels to walls and to pilasters with no fewer than three brackets attached at midpoint and near top and bottom of panel.
 - a. Locate wall brackets so holes for wall anchors occur in masonry or tile joints.
 - b. Align brackets at pilasters with brackets at walls.
- B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels, and adjust so tops of doors are parallel with overhead brace when doors are in closed position.
- C. Floor-Anchored Units: Set pilasters with anchors penetrating not less than 2 inches into structural floor unless otherwise indicated in manufacturer's written instructions. Level, plumb, and tighten pilasters. Hang doors and adjust so tops of doors are level with tops of pilasters when doors are in closed position.
- D. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

3.3 ADJUSTING

- A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION 102113.16

SECTION 102123 - DRESSING CURTAINS AND TRACK

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Dressing-curtain tracks and carriers.
 - 2. Dressing curtains.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For each type of curtain fabric indicated, include durability, laundry temperature limits, fade resistance, applied curtain treatments, and fire-test-response characteristics.
- B. Shop Drawings: For curtains and tracks.
 - 1. Show layout and types of dressing areas, sizes of curtains, number of carriers, anchorage details, and conditions requiring accessories. Indicate dimensions taken from field measurements.
 - 2. Include details of blocking for track support.
- C. Samples: For each exposed product and for each color and texture specified, 10 inches in size.
- D. Product Schedule: For curtains and tracks. Use same designations indicated on Drawings.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For curtains, tracks, and hardware to include in operation and maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Curtain Carriers and Track End Caps: Full-size units equal to 3 percent of amount installed for each size indicated, but no fewer than 10 units.
 - 2. Curtains: Full-size units equal to 10 percent of amount installed for each size indicated, but no fewer than one unit.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Curtains: Provide curtain fabrics with the following characteristics:
 - 1. Laundering: Launderable to a water temperature of not less than 160 deg F.
 - 2. Flame Resistance: Provide fabrics identical to those that have passed NFPA 701 when tested by a qualified testing agency acceptable to authorities having jurisdiction.
 - a. Identify fabrics with appropriate markings of a qualified testing agency.

2.2 DRESSING-CURTAIN SUPPORT SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ADC Hospital Equipment, Division of Automatic Devices Company.
 2. Creative Healthcare Products Inc.
 3. General Cubicle Company Inc.
 4. Imperial Fastener Company.
 5. Kirsch.
 6. On The Right Track System
- B. Extruded-Aluminum Curtain Track: Not less than 3/8 inch wide by 1-1/2 inch high.
1. Track Minimum Wall Thickness: Manufacturer's standard.
 2. Finish: Baked enamel, acrylic, or epoxy.
- C. Curtain Track Accessories: Fabricate splices, end caps, connectors, end stops, coupling and joining sleeves, wall flanges, brackets, ceiling clips, and other accessories from same material and with same finish as track.
- D. Curtain Carriers: Nylon glide or rollers with chrome-plated steel or aluminum hook.

2.3 CURTAINS

- A. Fabric: Curtain manufacturer's standard, 100 percent polyester; inherently and permanently flame resistant, stain resistant, and antimicrobial.
1. Color: As selected by Architect from manufacturer's full range.
- B. Curtain Grommets: Two-piece, rolled-edge, rustproof, nickel-plated brass; spaced not more than 6 inches o.c.; machined into top hem.
- C. Mesh Top: Not less than 20-inch- high, nylon mesh top.

2.4 CURTAIN FABRICATION

- A. Continuous Curtain Panels:
1. Width: Equal to track length from which curtain is hung plus 10 percent of added fullness, but not less than 12 inches of added fullness.
 2. Length: Equal to floor-to-ceiling height, minus depth of track and carrier at top, and minus clearance above the finished floor of 12 inches.
 3. Mesh Top: Top hem of mesh not less than 1 inch and not more than 1-1/2 inches wide, triple thickness, reinforced with integral web, and double lockstitched. Double lockstitch bottom of mesh directly to 1/2-inch triple thickness, top hem of curtain fabric.
 4. Bottom Hem: Not less than 1 inch and not more than 1-1/2 inches wide, double thickness and single lockstitched.
 5. Side Hems: Not less than 1/2 inch and not more than 1-1/4 inches wide, with double turned edges, and single lockstitched.
 6. Vertical Seams: Not less than 1/2 inch wide, double turned and double stitched.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install tracks level and plumb, according to manufacturer's written instructions.
- B. For tracks of up to 20 feet in length, provide track fabricated from single, continuous length.
 - 1. Curtain-Track Mounting: Surface.
- C. Surface-Track Mounting: Fasten tracks to ceilings at intervals recommended by manufacturer. Fasten tracks to structure at each splice and tangent point of each corner. Center fasteners in track to ensure unencumbered carrier operation. Attach track to ceiling as follows:
- D. Track Accessories: Install splices, end caps, connectors, end stops, coupling and joining sleeves, and other accessories as required for a secure and operational installation.
- E. Curtain Carriers: Provide curtain carriers adequate for 6-inch spacing along full length of curtain plus an additional carrier.
- F. Curtains: Hang curtains on each curtain track.

END OF SECTION 102123

SECTION 102233 - ACCORDION FOLDING PARTITIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Horizontal sliding, fire-rated accordion folding partitions.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For accordion folding partitions.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Indicate storage and operating clearances.
 - 3. Indicate location and installation requirements for hardware and track, blocking, and direction of travel.
 - 4. Include diagrams for power, signal, and control wiring.
- C. Delegated-Design Submittal: For seismic bracing of accordion folding partitions.
 - 1. Include design calculations for seismic restraints that brace tracks to structure above.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Partition track, track supports and seismic bracing, switches, turning space, and storage layout.
 - 2. Suspended ceiling components.
 - 3. Structural members to which suspension systems will be attached.
 - 4. Size and location of initial access modules for acoustical tile.
 - 5. Items penetrating finished ceiling, including the following:
 - a. Lighting fixtures.
 - b. HVAC ductwork, outlets, and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Smoke detectors.
 - f. Access panels.
 - 6. Plenum fire and smoke barriers.
- B. Setting Drawings: For embedded items and cutouts required in other work, including support-beam, mounting-hole template.
- C. Qualification Data: For Installer.

- D. Product Certificates: For each type of accordion folding partition, from manufacturer.
- E. Product Test Reports: For each accordion folding partition, for tests performed by a qualified testing agency.
- F. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For accordion folding partitions to include in maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Seals, hardware, track, carriers, and other operating components.
 - b. Electric operator and controls.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of accordion folding partitions that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Faulty operation of accordion folding partitions.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Period: One years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic bracing of tracks to structure above, according to the seismic performance requirements.
- B. Seismic Performance: Accordion folding partitions shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- C. Fire-Test-Response Characteristics: Provide partitions with finishes complying with one of the following, as determined by testing identical products by a testing and inspecting agency acceptable to authorities having jurisdiction:
 - 1. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.

2. Fire Growth Contribution: Complying with acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 286.
- D. Fire Resistance: Provide fire-rated accordion folding partitions complying with NFPA 80, based on testing according to UL 10B for fire-rated door assemblies.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 FIRE-RATED ACCORDION FOLDING PARTITION

- A. Fire-Rated Accordion Folding Partition: Accordion wall panels for horizontal extension and retraction that shall deploy automatically upon activation of the fire alarm.
 1. Basis of Design: Won-Door Corporation; FireGuard Accordion Folding Partition
- B. Partition Type: Single sliding-jamb partition with the following hardware:
 1. Exit Devices: Located on both sides of the fire door.
- C. Fire Rating: 1 hour.
- D. Automatic Closing System shall be listed to UL864 including capability to send and receive signals from the Fire Control Panel.
- E. Electric Controls: Key switch shall be provided for authorized operation of the door assembly, located as directed by Architect.

2.3 COMPONENTS

- A. Panels: 24 gauge enamel coated steel.
- B. Posts and Seals: Provide types of posts and seals that produce accordion folding partitions complying with performance requirements.
 1. Flat Lead Posts: Steel or aluminum; formed with deep-nesting and interlocking interfaces and fabricated to ensure rigidity of accordion folding partition.
 2. Perimeter Seals: Manufacturer's standard vinyl, neoprene, or woven silica vertical seals, horizontal top and bottom seals, and closures for lead posts and jambs. Seals and closures at fire-rated partitions shall be identical to products tested for fire rating indicated and shall form an effective smoke and draft seal.

2.4 SUSPENSION SYSTEMS

- A. Tracks: Steel or aluminum, mounted directly to overhead structural support, designed for operation, size, and weight of accordion folding partition indicated. Size track to support partition operation and storage without damage to suspension system, accordion folding partitions, or adjacent construction. Limit track deflection to no more than 0.10 inch between bracket supports. Provide a continuous system of track sections and accessories to accommodate configuration and layout indicated for partition operation and storage.
 1. Track: As indicated on Drawings.

- B. Carriers: Trolley system as required for size and weight of partition and for easy, quiet operation; with manufacturer's standard ball-bearing carriers at lead post and manufacturer's standard ball-bearing carriers at intermediate partition supports.
 - 1. Wheels: Manufacturer's standard.
- C. Aluminum Finish: Mill finish or manufacturer's standard, factory-applied, decorative finish unless otherwise indicated.
- D. Steel Finish: Factory-applied, corrosion-resistant, protective coating unless otherwise indicated.

2.5 ELECTRIC OPERATORS

- A. Factory-assembled electric operation system of size and capacity recommended and provided by accordion folding partition manufacturer for partition specified; with electric motor and factory-prewired motor controls, speed reducer, chain drive, remote-control stations, control devices, and accessories required for operation. Include wiring from control stations to motor. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
- B. Comply with NFPA 70.
- C. Motor Electrical Characteristics:
 - 1. Horsepower: Manufacturer's standard.
 - 2. Volts: 120.
 - 3. Hertz: 60.
- D. Control Equipment: Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6.
- E. Obstruction-Detection Device: For partitions indicated, provide automatic safety sensor indicated that causes operator to immediately stop and reverse direction.
 - 1. Sensor Edge: Contact-pressure-sensitive safety edge along partition's leading edge.
- F. Emergency Release Mechanism: For partitions indicated, provide quick disconnect-release of electric-motor drive system, permitting manual operation in event of operating failure.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine flooring, floor levelness, structural support, and opening, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of accordion folding partitions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with accordion folding partition manufacturer's written installation instructions. Install accordion folding partitions level and plumb, with tight joints and uniform appearance, and free of deformation and surface and finish irregularities.

- B. Install accordion folding partitions, seismic bracing, and accessories after other finishing operations, including painting, have been completed in area of partition installation.
- C. Broken, cracked, chipped, deformed, or unmatched sections are unacceptable.
- D. Broken, cracked, deformed, or unmatched seals or seals with gaps at butted ends are unacceptable.

3.3 ADJUSTING

- A. Adjust accordion folding partitions to operate smoothly, without warping or binding. Lubricate hardware and other moving parts as recommended by manufacturer.
- B. Electrically Operated Partitions: Adjust electric interlocks to properly control partition operation.
- C. Verify that safety devices are properly functioning.

END OF SECTION 102233

SECTION 102239 - FOLDING PANEL PARTITIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Manually operated, acoustical panel partitions.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For operable panel partitions.
 - 1. Include plans, elevations, sections, attachment details, and numbered panel installation sequence.
 - 2. Indicate stacking and operating clearances. Indicate location and installation requirements for hardware and track, blocking, and direction of travel.
 - 3. Include diagrams for power, signal, and control wiring.
- C. Samples for Initial Selection: For each type of exposed material, finish, covering, or facing.
 - 1. Include Samples of accessories involving color selection.
- D. Samples for Verification: For each type of exposed material, finish, covering, or facing, prepared on Samples of size indicated below:
 - 1. Panel Facing Material: Manufacturer's standard-size unit, not less than 3 inches square.
 - 2. Panel Edge Material: Not less than 3 inches long.
- E. Delegated-Design Submittal: For operable panel partitions.
 - 1. Include design calculations for seismic restraints that brace tracks to structure above.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Partition track, track supports and bracing, switches, turning space, and storage layout.
 - 2. Suspended ceiling components.
 - 3. Structural members to which suspension systems will be attached.
 - 4. Size and location of initial access modules for acoustical tile.
 - 5. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. HVAC ductwork, outlets, and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Smoke detectors.
 - f. Access panels.

6. Plenum acoustical barriers.

- B. Setting Drawings: For embedded items and cutouts required in other work, including support-beam, mounting-hole template.
- C. Qualification Data: For Installer.
- D. Seismic Qualification Certificates: For operable panel partitions, tracks, accessories, and components, from manufacturer. Include seismic capacity of partition assemblies to remain in vertical position during a seismic event and the following:
 - 1. Basis for Certification: Indicate whether certification is based on analysis, testing, or experience data, according to ASCE/SEI 7.
 - 2. Detailed description of partition anchorage devices on which the certification is based and their installation requirements.
- E. Product Certificates: For each type of operable panel partition.
- F. Product Test Reports: For each operable panel partition, for tests performed by a qualified testing agency.
- G. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For operable panel partitions to include in maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Panel finish facings and finishes for exposed trim and accessories. Include precautions for cleaning materials and methods that could be detrimental to finishes and performance.
 - b. Seals, hardware, track, track switches, carriers, and other operating components.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protectively package and sequence panels in order for installation. Clearly mark packages and panels with numbering system used on Shop Drawings. Do not use permanent markings on panels.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of operable panel partitions that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Faulty operation of operable panel partitions.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic bracing of tracks to structure above.
- B. Seismic Performance: Operable panel partitions shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the partition panels will remain in place without separation of any parts when subjected to the seismic forces specified."
- C. Acoustical Performance: Provide operable panel partitions tested by a qualified testing agency for the following acoustical properties according to test methods indicated:
 - 1. Sound-Transmission Requirements: Operable panel partition assembly tested for laboratory sound-transmission loss performance according to ASTM E90, determined by ASTM E413, and rated for not less than the STC indicated.
 - 2. Noise-Reduction Requirements: Operable panel partition assembly, identical to partition tested for STC, tested for sound-absorption performance according to ASTM C423, and rated for not less than the NRC indicated.
- D. Fire-Test-Response Characteristics: Provide panels with finishes complying with one of the following as determined by testing identical products by a testing and inspecting agency acceptable to authorities having jurisdiction:
 - 1. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.
 - 2. Fire Growth Contribution: Complying with acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 286.

2.2 OPERABLE ACOUSTICAL PANELS

- A. Operable Acoustical Panels: Partition system, including panels, seals, finish facing, suspension system, operators, and accessories.
 - 1. Basis of Design: Subject to compliance with requirements, provide basis of design indicated or comparable products by one of the following:
 - a. Modernfold, Inc.; Acousti-Seal Encore Single Panel Partitions (Basis of Design)
 - b. Advanced Equipment Corporation.
 - c. Hufcor, Inc.
- B. Panel Operation: Manually operated, individual panels.
- C. Panel Construction: As required to support panel from suspension components and with reinforcement for hardware attachment. Fabricate panels with tight hairline joints and concealed fasteners. Fabricate panels so finished in-place partition is rigid; level; plumb; aligned, with tight joints and uniform appearance; and free of bow, warp, twist, deformation, and surface and finish irregularities.
- D. Dimensions: Fabricate operable acoustical panel partitions to form an assembled system of dimensions indicated and verified by field measurements.

1. Panel Width: Equal widths.
- E. STC: Not less than 54.
- F. Panel Weight: 9.5 lb/sq. ft. maximum.
- G. Panel Thickness: Nominal dimension of 4-1/4 inches.
- H. Panel Materials:
 1. Steel Frame: Steel sheet, manufacturer's standard nominal minimum thickness for uncoated steel.
 2. Steel Face/Liner Sheets: Tension-leveled steel sheet, 0.0359-inch minimum nominal thickness for uncoated steel.
 3. Gypsum Board: ASTM C1396/C1396M.
- I. Panel Closure: Manufacturer's standard unless otherwise indicated.
- J. Hardware: Manufacturer's standard as required to operate operable panel partition and accessories; with decorative, protective finish.
 1. Hinges: Manufacturer's standard.
- K. Finish Facing: Wood veneer.

2.3 SEALS

- A. Description: Seals that produce operable panel partitions complying with performance requirements and the following:
 1. Manufacturer's standard seals unless otherwise indicated.
 2. Seals made from materials and in profiles that minimize sound leakage.
 3. Seals fitting tight at contact surfaces and sealing continuously between adjacent panels and between operable panel partition perimeter and adjacent surfaces, when operable panel partition is extended and closed.
- B. Vertical Seals: Deep-nesting, interlocking steel astragals mounted on each edge of panel, with continuous, resilient acoustical seal.
- C. Horizontal Top Seals: Continuous-contact, resilient seal exerting uniform constant pressure on track or resilient, mechanical, retractable, constant-force-contact seal exerting uniform constant pressure on track when extended.
- D. Horizontal Bottom Seals: Manufacturer's standard continuous-contact seal exerting uniform constant pressure on floor.

2.4 PANEL FINISH FACINGS

- A. Description: Finish facings for panels that comply with indicated fire-test-response characteristics and that are factory applied to operable panel partitions with appropriate backing, using mildew-resistant nonstaining adhesive as recommended by facing manufacturer's written instructions.
 1. Apply facings free of air bubbles, wrinkles, blisters, and other defects, with invisible seams complying with Shop Drawings for location, and with no gaps or overlaps. Horizontal butted edges or seams are not permitted. Tightly secure and conceal raw and selvage edges of facing for finished appearance.

2. Where facings with directional or repeating patterns or directional weave are indicated, mark facing top and attach facing in same direction.
3. Match facing pattern 72 inches above finished floor.

B. Wood Veneer: Laminated to noncombustible core with moisture-resistant adhesive.

1. Species and Cut: Select White Maple, plain sliced.
2. Matching of Adjacent Veneer Leaves: Slip match.
3. Veneer Matching within Panel Face: Balance match.
4. Panel-Matching Method: No matching between panels is required. Select and arrange panels for similarity of grain pattern and color between adjacent panels.
5. Wood-Veneer Finish: As selected by Architect from manufacturer's full range, as follows:
 - a. Type: Transparent finish over stain over wood variety indicated.

C. Cap-Trimmed Edges: Protective perimeter-edge trim with tight hairline joints concealing edges of panel and finish facing, finished as follows:

1. Steel, Painted: Finished with manufacturer's color as selected by Architect from manufacturer's full range.

2.5 SUSPENSION SYSTEMS

A. Tracks: Steel with adjustable steel hanger rods for overhead support, designed for operation, size, and weight of operable panel partition indicated. Size track to support partition operation and storage without damage to suspension system, operable panel partitions, or adjacent construction. Limit track deflection to no more than 0.10 inch between bracket supports. Provide a continuous system of track sections and accessories to accommodate configuration and layout indicated for partition operation and storage. Aluminum tracks are not acceptable.

1. Exposed Track Soffit: Steel, integral to track, and pre-painted off-white.
2. Head Closure Trim: As required for acoustical performance; with factory-applied, decorative, protective finish.

B. Carriers: Two all-steel trolleys with steel-tired ball bearing wheels. Non-steel tires are not acceptable. Suspension system shall provide automatic indexing of panels into stack area using preprogrammed switches and trolleys without electrical, pneumatic, or mechanical activation.

C. Steel Finish: Manufacturer's standard, factory-applied, corrosion-resistant, protective coating unless otherwise indicated.

2.6 ACCESSORIES

A. Storage Pocket Door: Full height at end of partition runs to conceal stacked partition; of same materials, finish, construction, thickness, and acoustical qualities as panels; complete with operating hardware and acoustical seals at soffit, floor, and jambs. Hinges in finish to match other exposed hardware.

1. Manufacturer's standard method to secure storage pocket door in closed position.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine flooring, floor levelness, structural support, and opening, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of operable panel partitions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install operable panel partitions and accessories after other finishing operations, including painting, have been completed in area of partition installation.
- B. Install panels in numbered sequence indicated on Shop Drawings.
- C. Broken, cracked, chipped, deformed, or unmatched panels are not acceptable.
- D. Broken, cracked, deformed, or unmatched gasketing or gasketing with gaps at butted ends is not acceptable.

3.3 ADJUSTING

- A. Adjust operable panel partitions, hardware, and other moving parts to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust storage pocket doors to operate smoothly and easily, without binding or warping.
- C. Verify that safety devices are properly functioning.

END OF SECTION 102239

SECTION 102800 - TOILET AND BATH ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Public-use washroom accessories.
 - 2. Public-use shower room accessories.
 - 3. Underlavatory guards.
 - 4. Custodial accessories.

1.2 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
 - 3. Include electrical characteristics.
- B. Samples: For each exposed product and for each finish specified, full size.
 - 1. Approved full-size Samples will be returned and may be used in the Work.
- C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
 - 1. Identify locations using room designations indicated.
 - 2. Identify accessories using designations indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For manufacturer's special warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For accessories to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED MATERIALS

- A. Owner-Furnished Materials:
1. Freestanding waste receptacles.

2.2 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. Structural Performance: Design accessories and fasteners to comply with the following requirements:
1. Grab Bars: Installed units are able to resist 250 lbf concentrated load applied in any direction and at any point.
 2. Shower Seats: Installed units are able to resist 360 lbf applied in any direction and at any point.

2.3 MANUFACTURERS

- A. Basis of Design: Subject to compliance with requirements, provide basis of design indicated or comparable products by one of the following:
1. American Specialties, Inc. (ASI)
 2. Bobrick Washroom Equipment.
 3. Bradley Corp.
 4. GAMCO Specialty Accessories.

2.4 PUBLIC-USE WASHROOM ACCESSORIES

- A. Source Limitations: Obtain each type of public-use washroom accessory from single source from single manufacturer.
- B. Toilet Tissue (Roll) Dispenser (**TT**):
1. Basis of Design: ASI; Model #20030, Roval Twin Hide-A-Roll Toilet Tissue Dispenser.
 2. Description: Roll-in-reserve dispenser that automatically drops into place when bottom roll is used up.
 3. Mounting: Surface mounted.
 4. Operation: Theft-resistant spindles with integral plated steel endpins.
 5. Capacity: Designed for 5-inch- diameter tissue rolls.
 6. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
- C. Automatic Paper Towel (Roll) Dispenser (**PTF1**):
1. Basis of Design: ASI; 045210A
 2. Description: Automatic motion sensing mechanism with user-adjustable delay and paper towel length.
 3. Mounting: Recessed.
 4. Minimum Capacity: 8-inch- wide, 800-foot- long roll.
 5. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
 6. Lockset: Tumbler type.
 7. Accessories: Provide manufacturer's standard A/C adapter conversion kit to convert paper towel dispenser into electrically operated.

D. Automatic Paper Towel (Roll) Dispenser (PTF2):

1. Basis of Design: ASI; 045210A-9
2. Description: Automatic motion sensing mechanism with user-adjustable delay and paper towel length.
3. Mounting: Surface mounted.
4. Minimum Capacity: 8-inch- wide, 800-foot- long roll.
5. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
6. Lockset: Tumbler type.
7. Accessories: Provide manufacturer's standard A/C adapter conversion kit to convert paper towel dispenser into electrically operated.

E. Automatic Soap Dispenser – Multi-Feed (SD1):

1. Basis of Design: ASI; 0390-(N).
2. Description: Automatic dispenser with infrared sensor to detect presence of hands.
3. Mounting: Deck mounted on vanity.
4. Capacity: 1.6 gal.
5. Materials: Polished chrome plated.
6. Refill Indicator: LED indicator.
7. Accessories: Provide manufacturer's standard A/C adapter conversion kit to convert soap dispenser into electrically operated.

F. Automatic Soap Dispenser – Stand-Alone (SD2):

1. Basis of Design: ASI; 0391-(N).
2. Description: Automatic dispenser with infrared sensor to detect presence of hands.
3. Mounting: Deck mounted on vanity.
4. Capacity: 33.8 oz.
5. Materials: Polished chrome plated.
6. Refill Indicator: LED indicator.
7. Accessories: Provide manufacturer's standard A/C adapter conversion kit to convert soap dispenser into electrically operated.

G. Grab Bar (GB18, GB24, GB36, GB42):

1. Basis of Design: ASI; 3800-P
2. Mounting: Flanges with concealed fasteners.
3. Material: Stainless steel, 0.05 inch thick.
 - a. Finish: Smooth, ASTM A480/A480M No. 4 finish (satin) on ends and slip-resistant texture in grip area.
4. Outside Diameter: 1-1/2 inches.
5. Configuration and Length: As indicated on Drawings.

H. Sanitary-Napkin Disposal Unit (SDU):

1. Basis of Design: ASI; 0852.
2. Mounting: Surface mounted.
3. Door or Cover: Self-closing, disposal-opening cover.
4. Receptacle: Unit is emptied by opening top door and removing wax paper collection bag. Bags provided by others.
5. Capacity: 1.2 gal.
6. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

I. Mirror Unit (MM):

1. Basis of Design: ASI; 0600 SERIES.

2. Frame: Stainless steel angle, 0.05 inch thick.
 - a. Corners: Welded and ground smooth.
3. Size: 18- by 36-inches.
4. Hangers: Manufacturer's standard rigid, tamper and theft resistant.

J. Custom Framed Full-Length Mirror **(FLM)**:

1. Frame:
 - a. Wood Species: Select white maple.
 - b. Profile: 4-inch flat profile with square edge.
 - c. Finish: Stained.
 - 1) Shop finished, manufacturer's standard transparent finish.
 - 2) Color: As selected by Architect from full range of industry colors.
2. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.5 PUBLIC-USE SHOWER ROOM ACCESSORIES

- A. Source Limitations: Obtain each type of public-use shower room accessory from single source from single manufacturer.

B. Shower Curtain Rod **(SHR)**:

1. Basis of Design: ASI; 1204-2
2. Description: 1-1/4-inch- outside diameter, straight rod.
3. Configuration: As indicated on Drawings
4. Mounting Flanges: Concealed fasteners; in manufacturer's standard material and finish.
5. Rod Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

C. Shower Curtain **(SHC)**:

1. Basis of Design: ASI; 1200-V.
2. Size: Minimum 6 inches wider than opening up to 42-inches, and 12-inches wider than opening over 42-inches, by 72 inches high.
3. Material: Vinyl, minimum 0.006 inch thick, opaque, matte
4. Color: White.
5. Grommets: Corrosion resistant at minimum 6 inches o.c. through top hem.
6. Shower Curtain Hooks:
 - a. Basis-of-Design Product: ASI; 1200-SHU.
 - b. Stainless steel, spring wire curtain hooks with snap fasteners, sized to accommodate specified curtain rod. Provide one hook per curtain grommet.

D. Folding Shower Seat **(SHS)**:

1. Basis of Design: ASI; 8206.
2. Configuration: L-shaped seat, designed for wheelchair access.
3. Seat: Phenolic composite of slat-type or one-piece construction in white.
4. Mounting Mechanism: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
5. Dimensions: 33-inches long, and projects 22-7/8-inches from wall..

E. Robe Hook **(RB1)**:

1. Basis of Design: ASI; 7308.
2. Description: Single-prong unit.
3. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

2.6 CHILDCARE ACCESSORIES

- A. Source Limitations: Obtain each type of childcare accessory from single source from single manufacturer.
- B. Diaper-Changing Station (**DCS**):
 - 1. Basis of Design: ASI 9013-9 Roval
 - 2. Description: Horizontal unit that opens by folding down from stored position and with child-protection strap.
 - a. Engineered to support minimum of 250-lb static load when opened.
 - 3. Mounting: Surface mounted, with unit projecting not more than 4 inches from wall when closed.
 - 4. Operation: By pneumatic shock-absorbing mechanism.
 - 5. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin), exterior shell with rounded plastic corners; HDPE interior in manufacturer's standard color.
 - 6. Liner Dispenser: Provide built-in dispenser for disposable sanitary liners.

2.7 UNDERLAVATORY GUARDS

- A. Underlavatory Guard:
 - 1. Manufacturers: Subject to compliance with requirements, provide products from one of the following:
 - a. Buckaroos, Inc.
 - b. Plumberex Specialty Products, Inc.
 - c. Truebro by IPS Corp.
 - 2. Description: Insulating pipe covering for supply and drain piping assemblies that prevents direct contact with and burns from piping; allow service access without removing coverings.
 - 3. Material and Finish: Antimicrobial, molded plastic, white.

2.8 CUSTODIAL ACCESSORIES

- A. Source Limitations: Obtain each type of custodial accessory from single source from single manufacturer.
- B. Custodial Mop and Broom Holder:
 - 1. Basis of Design: Bradley Corp.; 9953 Mop and Broom Holder, 3 Holders.
 - 2. Description: Spring-activated rubber cams on plated steel retainers. Will hold a mop or broom handle with a diameter between 5/8-inch and 1-inch..
 - 3. Length: 36 inches.
 - 4. Mop/Broom Holders: Three, spring-loaded, rubber hat, cam type.
 - 5. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
 - a. Shelf: Not less than nominal 0.05-inch- thick stainless steel.
 - b. Rod: Approximately 1/4-inch- diameter stainless steel.

2.9 MATERIALS

- A. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.031-inch- minimum nominal thickness unless otherwise indicated.
- B. Fasteners: Screws, bolts, and other devices of same material as accessory unit, unless otherwise recommended by manufacturer or specified in this Section, and tamper and theft resistant where exposed, and of stainless or galvanized steel where concealed.

- C. Chrome Plating: ASTM B456, Service Condition Number SC 2 (moderate service).
- D. Mirrors: ASTM C1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.10 FABRICATION

- A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
- B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
 - 1. Remove temporary labels and protective coatings.
- B. Grab Bars: Install to comply with specified structural-performance requirements.
- C. Shower Seats: Install to comply with specified structural-performance requirements.

3.2 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Clean and polish exposed surfaces according to manufacturer's written instructions.

END OF SECTION 102800

SECTION 104413 - FIRE PROTECTION CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire-protection cabinets for portable fire extinguisher.

B. Related Requirements:

1. Section 104416 "Fire Extinguishers" for portable, hand-carried fire extinguishers accommodated by fire-protection cabinets

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing mounting method and relationships of box and trim to surrounding construction.

B. Shop Drawings: For fire-protection cabinets.

1. Include plans, elevations, sections, details, and attachments to other work.

C. Product Schedule: For fire-protection cabinets. Indicate whether recessed, semirecessed, or surface mounted. Coordinate final fire-protection cabinet schedule with fire-extinguisher schedule to ensure proper fit and function.

1.3 COORDINATION

A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

C. Provide fire rated cabinets where indicated to be installed in fire rated walls.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:

1. Amerex Corporation
2. Ansul Incorporated; Tyco International
3. Babcock-Davis
4. Badger Fire Protection; a Kidde company
5. JL Industries
6. Kidde Residential and Commercial Division; Subsidiary of Kidde plc.
7. Larsens Manufacturing Company
8. Potter Roemer LLC

- B. Source Limitations: Obtain fire-protection cabinets, accessories, and fire extinguishers from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E814 for fire-resistance rating of walls where they are installed.

2.3 FIRE-PROTECTION CABINET

- A. Cabinet Type: Suitable for fire extinguisher.
- B. Cabinet Construction: Rated and nonrated as required to match rating of wall assembly.
 - 1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.043-inch-thick cold-rolled steel sheet lined with minimum 5/8-inch-thick fire-barrier material. Provide factory-drilled mounting holes.
- C. Cabinet Material: Cold-rolled steel sheet.
 - 1. Shelf: Same metal and finish as cabinet.
- D. Semirecessed Cabinet: One-piece combination trim and perimeter door frame overlapping surrounding wall surface, with exposed trim face and wall return at outer edge (backbend).
 - 1. Rolled-Edge Trim: 2-1/2-inch backbend depth.
- E. Cabinet Trim Material: Steel sheet.
- F. Door Material: Steel sheet.
- G. Door Style: Vertical duo panel with frame.
- H. Door Glazing: Tempered float glass (clear).
- I. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
 - 1. Provide projecting lever handle with cam-action latch.
 - 2. Provide concealed hinge, permitting door to open 180 degrees.
- J. Accessories:
 - 1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
 - 2. Door Lock: Cam lock that allows door to be opened during emergency by pulling sharply on door handle.
 - 3. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as directed by Architect.
 - a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."
 - 1) Location: Applied to cabinet door or cabinet glazing.
 - 2) Application Process: Decals or pressure-sensitive vinyl letters.
 - 3) Lettering Color: Red.

4) Orientation: Vertical.

K. Materials:

1. Cold-Rolled Steel: ASTM A1008/A1008M, Commercial Steel (CS), Type B.
 - a. Finish: Baked enamel, TGIC polyester powder coat, HAA polyester powder coat, epoxy powder coat, or polyester/epoxy hybrid powder coat, complying with AAMA 2603.
 - b. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - c. Color: As selected by Architect from manufacturer's full range.
2. Tempered Float Glass: ASTM C1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).

2.4 FABRICATION

- A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
 1. Weld joints and grind smooth.
 2. Provide factory-drilled mounting holes.
- B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.
 1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
 2. Miter and weld perimeter door frames and grind smooth.
- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.5 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
- C. Finish fire-protection cabinets after assembly.
- D. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls and partitions for suitable framing depth and blocking where semirecessed cabinets will be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare recesses for semirecessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

- A. General: Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.
- B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.
 - 1. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.
- C. Identification: Apply vinyl lettering.

3.4 ADJUSTING AND CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as fire-protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
- D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet and mounting bracket manufacturers.
- E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 104413

SECTION 104416 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.
- B. Related Requirements:
 - 1. Section 104413 "Fire Protection Cabinets."

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.
- B. Product Schedule: For fire extinguishers.

1.3 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.5 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Faulty operation of valves or release levers.
 - 2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

1. Provide fire extinguishers approved, listed, and labeled by FM Global.
2. Provide fire extinguishers in elevator mechanical/control rooms that comply with North Carolina Department of Labor requirements.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each mounting bracket indicated.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Amerex Corporation.
 - b. Ansul Incorporated; Tyco International Ltd.
 - c. Badger Fire Protection; a Kidde company.
 - d. J.L. Industries, Inc.
 - e. Kidde Residential and Commercial Division; Subsidiary of Kidde plc.
 - f. Larsen's Manufacturing Company.
 - g. Potter-Roemer; Div. of Smith Industries, Inc.
 2. Source Limitations: Obtain fire extinguishers, fire-protection cabinets, and accessories, from single source from single manufacturer.
 3. Valves: Manufacturer's standard.
 4. Handles and Levers: Manufacturer's standard.
 5. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging.
- B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 4-A:60-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

2.3 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
1. Source Limitations: Obtain mounting brackets and fire extinguishers from single source from single manufacturer.
- B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
 - a. Orientation: Vertical.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fire extinguishers for proper charging and tagging.
1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
 - 1. Mounting Brackets: Top of fire extinguisher to be at 42 inches above finished floor.
- B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION 104416

SECTION 105123 - PLASTIC-LAMINATE-CLAD LOCKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plastic-laminate-clad wood lockers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of locker.

B. Shop Drawings: For plastic-laminate-clad wood lockers.

1. Include plans, elevations, sections, and attachment details.
2. Show details full size.
3. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
4. Show locations and sizes of cutouts and holes for items installed in lockers.
5. Show locker fillers, trim, base, and accessories.
6. Show locker identification system and numbering sequence.

C. Samples: For high-pressure decorative laminates.

1.3 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver lockers until painting and similar operations that could damage lockers have been completed in installation areas. If lockers must be stored in other-than-installation areas, store only in areas where environmental conditions are the same as those in final installation location, and comply with requirements specified in "Field Conditions" Article.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install lockers until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity in manufacturer's standard range during the remainder of the construction period.

- B. Field Measurements: Where lockers are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings.
 - 1. Locate concealed framing, blocking, and reinforcements that support lockers by field measurements before being enclosed, and indicate measurements on Shop Drawings.
- C. Established Dimensions: Where lockers are indicated to fit to other construction, establish dimensions for areas where lockers are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.7 COORDINATION

- A. Coordinate sizes and locations of support bases.
- B. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that lockers can be supported and installed as indicated.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of lockers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures.
 - b. Faulty operation of locks or hardware.
 - c. Deterioration of wood, finishes, and other materials beyond normal use.
 - 2. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: For lockers indicated to be accessible, comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and ICC A117.1.

2.2 PLASTIC-LAMINATE-CLAD WOOD LOCKERS

- A. Manufacturers: Subject to compliance with requirements, provide products from one of the following:
 - 1. Hollman, Inc.
 - 2. Ideal Products, Inc.
 - 3. Legacy Lockers.
- B. Locker Arrangement: Double tier and triple tier in locations as indicated on Drawings.
- C. Construction Style: Flush overlay.
- D. Final Assembly: Manufacturer's standard factory assembly.
- E. Locker Body: Fabricated from particleboard -core panels covered on both sides with thermoset decorative overlay.
 - 1. Side, Top, and Bottom Panels: Manufacturer's standard 3/4 or 5/8 inch thick.

2. Back Panel: Manufacturer's standard 1/2 or 3/8 inch thick.
 3. Exposed Panel Edges: High-pressure decorative laminate, Grade HGS, to match panels.
- F. Plastic-Laminate-Clad Wood Doors: High-pressure decorative laminate, Grade VGS, over both sides of particleboard core.
1. Thickness: Manufacturer's standard 3/4 or 5/8 inch thick.
 2. Panel Edges: 3-mm-thick PVC High-pressure decorative laminate, Grade HGS, to match panels.
- G. End Panels: Match style, material, construction, and finish of plastic-laminate-clad wood doors.
- H. Shelves: Fabricated from particleboard -core panels covered on both sides with thermoset decorative overlay; fixed.
1. Thickness: 5/8 inch.
 2. Exposed Edges: Thermoset decorative overlay to match panels.
- I. Corners and Filler Panels: 3/4-inch- thick panels. Match style, material, construction, and finish of plastic-laminate-clad wood doors.
- J. Continuous Finish Base (in areas other than wet areas): Plastic-laminate-clad, 3/4-inch- thick panel that matches door faces; fabricated in lengths as long as practical to enclose base and base ends of lockers.
- K. Plastic-Laminate Colors, Patterns, and Finishes (**PLM-10**): As indicated on Material Finishes Legend.

2.3 MATERIALS

- A. Composite Wood: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.
1. Thermoset Decorative Panels: Particleboard or medium-density fiberboard finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD 3, Grade VGL, for Test Methods 3.3, 3.4, 3.6, 3.8, and 3.10.
 2. Medium-Density Fiberboard: ANSI A208.2, Grade 130.
 3. Particleboard: ANSI A208.1, Grade M-2-Exterior Glue.
- B. High-Pressure Decorative Laminate: NEMA LD 3, grades as follows:
1. Horizontal Surfaces: Grade HGS.
 2. Vertical Surfaces: Grade VGS.
- C. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.
- D. Anchors: Material, type, size, and finish as required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

2.4 HARDWARE

- A. Cam Padlock Hasp: Surface mounted, steel; finished to match other locker hardware.
- B. Digital Keypad Lock: Battery-powered electronic keypad with reprogrammable manager and owner codes that override access. Three consecutive incorrect code entries shall disable lock for three minutes.

1. Designed for shared or temporary access by multiple users, with user-defined code to lock and unlock. Provide LED indicator to show when lock is in use.
 - C. Frameless Hinges (European Type): Fully concealed, soft-closing, nickel-plated steel, with not less than 125 degrees of opening.
 1. Provide two hinges for doors 42 inches high and less.
 2. Provide three hinges for doors more than 42 inches high.
 - D. Wire Pulls: Back mounted; 4 inches long, 5/16 inch in diameter.
 - E. Hooks: Manufacturer's standard, ball-pointed aluminum or steel; finished to match other locker hardware. Attach hooks with at least two fasteners.
 1. Provide two single-prong wall hooks for each compartment of double-tier and triple-tier lockers.
 - F. Exposed Hardware Finish: Satin chrome.
- 2.5 ACCESSORIES
- A. Number Identification Plates: 1-1/2-inch- diameter, etched, embossed, or stamped, stainless-steel plates with black numbers and letters at least 1/2 inch high. Identify lockers in sequence indicated on Drawings. Finish plates to match other locker hardware.
- 2.6 FABRICATION
- A. Fabricate each locker with shelves, an individual door and frame, an individual top, a bottom, and a back, and with common intermediate uprights separating compartments.
 1. Fabricate lockers to dimensions, profiles, and details indicated.
 2. Ease edges of corners of solid-wood members to 1/16-inch radius.
 - B. Fabricate lockers square, rigid, without warp, and with finished faces flat and free of dents, scratches, and chips. Accurately factory machine components for attachments. Make joints tight and true.
 1. Fabricate lockers using manufacturer's standard construction, with joints made with dowels, dados, or rabbets. Dado side panels to receive shelving except where indicated to be adjustable.
 - C. Accessible Lockers: Fabricate as follows:
 1. Locate bottom shelf no lower than 15 inches above the floor.
 2. Where hooks or additional shelves are provided, locate no higher than 48 inches above the floor.
 - D. Venting: Fabricate lockers with space between doors and locker assembly of not less than 1/4 inch.
 - E. Number Identification Plates: Inlay number plates flush in each locker door, near top, centered.
 - F. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible, before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
 1. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that the parts fit as intended, and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.

- G. Shop cut openings, to maximum extent possible, to receive hardware, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls and floors or support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify that furring is attached to concrete and masonry walls that are to receive lockers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Condition lockers to average prevailing humidity conditions in installation areas before installation.
- B. Before installing lockers, examine factory-fabricated work for completeness and complete work as required, including removal of packing.

3.3 INSTALLATION

- A. Install lockers level, plumb, and true; use concealed shims.
- B. Connect groups of lockers together with manufacturer's standard fasteners, through predrilled holes, with no exposed fasteners on face frames. Fit lockers accurately together to form flush, tight, hairline joints.
- C. Install lockers without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings, providing unencumbered operation. Complete installation of hardware and accessory items as indicated.
 - 1. Installation Tolerance: No more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line. Shim as required with concealed shims.
- D. Locker Anchorage: Fasten lockers through back, near top and bottom, at ends with No. 8 pan- or bugle-head wood screws sized for 1-inch penetration into wood framing, blocking, or furring and spaced not more than 16 inches o.c.
- E. Scribe and cut corner and filler panels to fit adjoining work using fasteners concealed where practical. Repair damaged finish at cuts.
- F. Install number identification plates after lockers are in place.
 - 1. Attach number identification plate on each locker door, near top, centered, with at least two screws with finish matching the plate.

3.4 ADJUSTING

- A. Clean, lubricate, and adjust hardware. Adjust doors to operate easily without binding.

3.5 PROTECTION

- A. Protect lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit use during construction.
- B. Touch up marred finishes, or replace lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION 105123

SECTION 122113 - HORIZONTAL LOUVER BLINDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Horizontal louver blinds with aluminum slats.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For horizontal louver blinds, include fabrication and installation details.
- C. Samples: For each exposed product and for each color and texture specified, 12 inches long.
- D. Product Schedule: For horizontal louver blinds. Use same designations indicated on Drawings.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For horizontal louver blinds to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 - 1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver horizontal louver blinds in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Do not install horizontal louver blinds until construction and wet-work and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where horizontal louver blinds are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain horizontal louver blinds from single source from single manufacturer.

2.2 HORIZONTAL LOUVER BLINDS, ALUMINUM SLATS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Caco Inc.
 2. Faber
 3. Hunter Douglas Contract
 4. Kirsch
 5. Levolor Contract; a Newell Rubbermaid company
 6. Springs Window Fashions
- B. Slats: Aluminum; alloy and temper recommended by producer for type of use and finish indicated; with crowned profile and radius corners.
1. Width: 1 inch.
 2. Thickness: Not less than 0.008 inch.
 3. Spacing: Manufacturer's standard.
 4. Finish: Ionized antistatic, dust-repellent, baked polyester finish with reflective finish on outside-facing surface of slat to enhance reflection of solar energy.
- C. Headrail: Formed steel or extruded aluminum; long edges returned or rolled. Headrails fully enclose operating mechanisms on three sides.
1. Capacity: One blind(s) per headrail unless otherwise indicated.
 2. Ends: Capped or plugged.
 3. Manual Lift Mechanism:
 - a. Lift-Cord Lock: Variable; stops lift cord at user-selected position within blind full operating range.
 - b. Operator: Extension of lift cord(s) through lift-cord lock mechanism to form cord pull.
 4. Manual Tilt Mechanism: Enclosed worm-gear mechanism and linkage rod that adjusts ladders.
 - a. Tilt: Full.
 - b. Operator: Clear-plastic wand.
 - c. Over-Rotation Protection: Manufacturer's detachable operator or slip clutch to prevent over rotation of gear.
 5. Manual Lift-Operator and Tilt-Operator Lengths: Full length of blind when blind is fully closed.
 6. Manual Lift-Operator and Tilt-Operator Locations: Manufacturer's standard unless otherwise indicated.
- D. Bottom Rail: Formed-steel or extruded-aluminum tube that secures and protects ends of ladders and lift cords and has plastic- or metal-capped ends.
1. Type: Top contoured to match crowned shape of slat.
- E. Lift Cords: Manufacturer's standard braided cord.
- F. Ladders: Evenly spaced across headrail at spacing that prevents long-term slat sag.
1. Type: Braided cord.

- G. Valance: Manufacturer's standard.
- H. Mounting Brackets: With spacers and shims required for blind placement and alignment indicated.
 - 1. Type: End.
 - 2. Intermediate Support: Provide intermediate support brackets to produce support spacing recommended by blind manufacturer for weight and size of blind.
- I. Hold-Down Brackets and Hooks or Pins: Manufacturer's standard.
- J. Colors, Textures, Patterns, and Gloss:
 - 1. Slats: As selected by Architect from manufacturer's full range.
 - 2. Components: Provide rails, cords, ladders, and materials exposed to view matching or coordinating with slat color unless otherwise indicated.

2.3 HORIZONTAL LOUVER BLIND FABRICATION

- A. Product Safety Standard: Fabricate horizontal louver blinds to comply with WCMA A 100.1 including requirements for corded, flexible, looped devices; lead content of components; and warning labels.
- B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:
 - 1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which blind is installed less 1/4 inch per side or 1/2 inch total, plus or minus 1/8 inch. Length equal to head-to-sill dimension of opening in which blind is installed less 1/4 inch, plus or minus 1/8 inch.
- C. Concealed Components: Noncorrodible or corrosion-resistant-coated materials.
 - 1. Lift-and-Tilt Mechanisms: With permanently lubricated moving parts.
- D. Mounting and Intermediate Brackets: Designed for removal and reinstallation of blind without damaging blind and adjacent surfaces, for supporting blind components, and for bracket positions and blind placement indicated.
- E. Installation Fasteners: No fewer than two fasteners per bracket, fabricated from metal noncorrosive to brackets and adjoining construction; type designed for securing to supporting substrate; and supporting blinds and accessories under conditions of normal use.
- F. Color-Coated Finish:
 - 1. Metal: For components exposed to view, apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, **[locations of connections to building electrical system,]** and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install horizontal louver blinds level and plumb, aligned and centered on openings, and aligned with adjacent units according to manufacturer's written instructions.
 - 1. Locate so exterior slat edges are not closer than 1 inch from interior faces of glass and not closer than 1/2 inch from interior faces of glazing frames through full operating ranges of blinds.
 - 2. Install mounting and intermediate brackets to prevent deflection of headrails.
 - 3. Install with clearances that prevent interference with adjacent blinds, adjacent construction, and operating hardware of glazed openings, other window treatments, and similar building components and furnishings.

3.3 ADJUSTING

- A. Adjust horizontal louver blinds to operate free of binding or malfunction through full operating ranges.

3.4 CLEANING AND PROTECTION

- A. Clean horizontal louver blind surfaces after installation according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions in a manner acceptable to manufacturer and Installer that ensures that horizontal louver blinds are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged horizontal louver blinds that cannot be repaired in a manner approved by Architect before time of Substantial Completion.

END OF SECTION 122113

SECTION 123623.13 - PLASTIC-LAMINATE-CLAD COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Plastic-laminate-clad countertops.
 - 2. Acrylic backsplash.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For plastic-laminate-clad countertops.
 - 1. Include plans, sections, details, and attachments to other work. Detail fabrication and installation, including field joints.
 - 2. Show locations and sizes of cutouts and holes for items installed in plastic-laminate-clad countertops.
- C. Samples: Plastic laminates in each type, color, pattern, and surface finish required in manufacturer's standard size.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.4 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
 - 1. Shop Certification: AWI's Quality Certification Program accredited participant.
- B. Installer Qualifications: Fabricator of products.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver countertops only after casework and supports on which they will be installed have been completed in installation areas.
- B. Store countertops in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.
- C. Keep surfaces of countertops covered with protective covering during handling and installation.

1.6 FIELD CONDITIONS

- A. Environmental Limitations without Humidity Control: Do not deliver or install countertops until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and

relative humidity at levels planned for building occupants during the remainder of the construction period.

- B. Field Measurements: Where countertops are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Established Dimensions: Where countertops are indicated to fit to other construction, establish dimensions for areas where countertops are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 FABRICATORS

- A. Fabricators: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cabinets by Design, Duluth, GA
 - 2. Cleora Sterling
 - 3. LSI Corporation
 - 4. Pridgen Millwork
 - 5. Stephenson Millwork
 - 6. Stevens Industries, Inc.

2.2 PLASTIC-LAMINATE-CLAD COUNTERTOPS

- A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of plastic-laminate-clad countertops indicated for construction, finishes, installation, and other requirements.
 - 1. The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with requirements of Contract Documents in addition to those of the referenced quality standard.
- B. Grade: Custom.
- C. High-Pressure Decorative Laminate (**PLM-1, PLM-3, PLM-5, PLM-6, PLM-8**): NEMA LD 3, Grade HGS.
 - 1. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
 - a. Formica Corporation
 - b. Pionite; a Panolam Industries International, Inc. brand.
 - c. Nevamar
 - d. Wilsonart
- D. Edge Treatment: Same as laminate cladding on horizontal surfaces.
- E. Core Material: Particleboard.
- F. Core Material at Sinks: Particleboard made with exterior glue.
- G. Core Thickness: 3/4 inch.

- H. Backer Sheet: Provide plastic-laminate backer sheet, NEMA LD 3, Grade BKL, on underside of countertop substrate.

2.3 WOOD MATERIALS

- A. Wood Products: Provide materials that comply with requirements of referenced quality standard unless otherwise indicated.
 - 1. Wood Moisture Content: 5 to 10 percent.
- B. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of countertop and quality grade specified unless otherwise indicated.
 - 1. MDF: Medium-density fiberboard, ANSI A208.2, Grade 130.
 - 2. Particleboard: ANSI A208.1, Grade M-2 or Grade M-2-Exterior Glue.
 - 3. Softwood Plywood: DOC PS 1.

2.4 ACRYLIC BACKSPLASH

- A. Acrylic Backsplash: Provide clear acrylic panels with polished, rounded edges, 1/4-inch thick.

2.5 ACCESSORIES

- A. Countertop Brackets: Heavy duty workstation brackets. Under-counter support frames, legs and miscellaneous metal parts shall be aluminum or steel, welded, degreased, cleaned, treated and powder-coated.
- B. Grommets for Cable Passage through Countertops: 2-inch OD, molded-plastic grommets and matching plastic cap with slot for wire passage; color as selected by Architect.

2.6 MISCELLANEOUS MATERIALS

- A. Adhesive for Bonding Plastic Laminate: Manufacturer's standard.

2.7 FABRICATION

- A. Complete fabrication, including assembly, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
 - 1. Notify Architect seven days in advance of the dates and times countertop fabrication will be complete.
 - 2. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended, and check measurements of assemblies against field measurements before disassembling for shipment.
- B. Shop cut openings to maximum extent possible to receive appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately, and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
 - 1. Seal edges of cutouts by saturating with varnish.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition countertops to average prevailing humidity conditions in installation areas.
- B. Before installing countertops, examine shop-fabricated work for completion and complete work as required, including removal of packing.

3.2 INSTALLATION

- A. Grade: Install countertops to comply with same grade as item to be installed.
- B. Assemble countertops and complete fabrication at Project site to the extent that it was not completed in the shop.
 - 1. Provide cutouts for appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately, and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
 - 2. Seal edges of cutouts by saturating with varnish.
- C. Field Jointing: Where possible, make in the same manner as shop jointing, using dowels, splines, adhesives, and fasteners recommended by manufacturer. Prepare edges to be joined in shop so Project-site processing of top and edge surfaces is not required. Locate field joints where shown on Shop Drawings.
 - 1. Secure field joints in countertops with concealed clamping devices located within 6 inches of front and back edges and at intervals not exceeding 24 inches. Tighten in accordance with manufacturer's written instructions to exert a constant, heavy-clamping pressure at joints.
- D. Scribe and cut countertops to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- E. Countertop Installation: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
 - 1. Install countertops level and true in line. Use concealed shims as required to maintain not more than a 1/8-inch-in-96-inches variation from a straight, level plane.
 - 2. Secure backsplashes to tops with concealed metal brackets at 16 inches o.c. and to walls with adhesive.
 - 3. Seal joints between countertop and backsplash, if any, and joints where countertop and backsplash abut walls with mildew-resistant silicone sealant or another permanently elastic sealing compound recommended by countertop material manufacturer.

3.3 ADJUSTING AND CLEANING

- A. Repair damaged and defective countertops, where possible, to eliminate functional and visual defects. Where not possible to repair, replace countertops. Adjust joinery for uniform appearance.
- B. Clean countertops on exposed and semiexposed surfaces.
- C. Protection: Provide suitable covering over countertop surfaces, taped to underside of countertop at a minimum of 48 inches o.c. Remove protection at Substantial Completion.

END OF SECTION 123623.13

SECTION 123661.16 - SOLID SURFACING COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Solid surface material countertops.
 - 2. Solid surface material backsplashes.
 - 3. Solid surface material end splashes.

1.2 ACTION SUBMITTALS

- A. Product Data: For countertop materials.
- B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.
 - 1. Show locations and details of joints.
 - 2. Show direction of directional pattern, if any.
- C. Samples for Initial Selection: For each type of material exposed to view.
- D. Samples for Verification: For the following products:
 - 1. Countertop material, 6 inches square.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For solid surface material countertops to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate countertops similar to that required for this Project, and whose products have a record of successful in-service performance.
- B. Installer Qualifications: Fabricator of countertops.
- C. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for fabrication and execution.
 - 1. Build mockup of typical countertop as shown on Drawings.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 FIELD CONDITIONS

- A. Field Measurements: Verify dimensions of countertops by field measurements after base cabinets are installed but before countertop fabrication is complete.

1.7 COORDINATION

- A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 SOLID SURFACE COUNTERTOP MATERIALS

- A. Solid Surface Material (**SSM-1, SSM-2**): Homogeneous-filled plastic resin complying with ICPA SS-1.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Avonite Surfaces.
 - b. Durasein Solid Surface; a brand of Relang International, LLC.
 - c. E. I. du Pont de Nemours and Company.
 - d. Formica Corporation.
 - e. Hanwha Surfaces
 - f. LG Chemical, Ltd.
 - g. Samsung Chemical USA, Inc.
 - h. Transolid Div of Trumbull Industries.
 - i. Wilsonart LLC.
 - 2. Type: Provide Standard type unless Special Purpose type is indicated.
 - 3. Colors and Patterns: As selected by Architect from manufacturer's full range.

2.2 COUNTERTOP FABRICATION

- A. Fabricate countertops according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WI's "Architectural Woodwork Standards."
 - 1. Grade: Custom.
- B. Configuration:
 - 1. Front: Straight, slightly eased at top.
 - 2. Backsplash: Straight, slightly eased at corner.
 - 3. End Splash: Matching backsplash.
- C. Countertops: 1/2-inch- thick, solid surface material.
- D. Backsplashes: 1/2-inch- thick, solid surface material.
- E. Fabricate tops with shop-applied edges and backsplashes unless otherwise indicated. Comply with solid surface material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
 - 1. Fabricate with loose backsplashes for field assembly.
- F. Joints: Fabricate straight countertops eight feet or less in length without joints.

- G. Joints: Fabricate countertops in sections for joining in field, with joints at locations as approved by Architect.
1. Joint Locations: Not within 18 inches of a sink and not where a countertop section less than 36 inches long would result, unless unavoidable.
 2. Splined Joints: Accurately cut kerfs in edges at joints for insertion of metal splines to maintain alignment of surfaces at joints. Make width of cuts slightly more than thickness of splines to provide snug fit. Provide at least three splines in each joint.
- H. Cutouts and Holes:
1. Undercounter Plumbing Fixtures: Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.
 - a. Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting 3/16 inch into fixture opening.
 2. Counter-Mounted Plumbing Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
 3. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.

2.3 INSTALLATION MATERIALS

- A. Adhesive: Product recommended by solid surface material manufacturer.
- B. Sealant for Countertops: Comply with applicable requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates to receive solid surface material countertops and conditions under which countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install countertops level to a tolerance of 1/8 inch in 8 feet, 1/4 inch maximum. Do not exceed 1/64-inch difference between planes of adjacent units.
- B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Predrill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- C. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.
- D. Secure countertops to subtops with adhesive according to solid surface material manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to

comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

- E. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.
 - 1. Install metal splines in kerfs in countertop edges at joints. Fill kerfs with adhesive before inserting splines and remove excess immediately after adjoining units are drawn into position.
 - 2. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.
- F. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
- G. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
- H. Apply sealant to gaps at walls; comply with Section 079200 "Joint Sealants."

END OF SECTION 123661.16

SECTION 123661.19 - QUARTZ AGGLOMERATE COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Quartz agglomerate countertops.
 - 2. Quartz agglomerate backsplashes.
 - 3. Quartz agglomerate end splashes.

1.2 ACTION SUBMITTALS

- A. Product Data: For countertop materials.
- B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.
 - 1. Show locations and details of joints.
 - 2. Show direction of directional pattern, if any.
- C. Samples: For each type of material exposed to view.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For quartz agglomerate countertops to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate countertops similar to that required for this Project, and whose products have a record of successful in-service performance.
- B. Installer Qualifications: Fabricator of countertops.
- C. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for fabrication and execution.
 - 1. Build mockup of typical countertop as shown on Drawings.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 FIELD CONDITIONS

- A. Field Measurements: Verify dimensions of countertops by field measurements after base cabinets are installed but before countertop fabrication is complete.

1.7 COORDINATION

- A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 QUARTZ AGGLOMERATE COUNTERTOP MATERIALS

- A. Quartz Agglomerate (**QSS-1, QSS-2**): Solid sheets consisting of quartz aggregates bound together with a matrix of filled plastic resin and complying with ICPA SS-1, except for composition.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. C&C North America, Inc.; Cosentino North America.
 - b. Cambria.
 - c. E. I. du Pont de Nemours and Company.
 - d. LG Chemical, Ltd.
 - e. Samsung Chemical USA, Inc.
 - f. Wilsonart LLC.
 - 2. Colors and Patterns: As selected by Architect from manufacturer's full range.

2.2 ACCESSORIES

- A. Countertop Brackets: Heavy duty workstation brackets. Under-counter support frames, legs and miscellaneous metal parts shall be aluminum or steel, welded, degreased, cleaned, treated and powder-coated.
- B. Grommets for Cable Passage through Countertops: 2-inch OD, stainless-steel grommets and matching cap with slot for wire passage; finish as selected by Architect.

2.3 COUNTERTOP FABRICATION

- A. Fabricate countertops according to quartz agglomerate manufacturer's written instructions and the AWI/AWMAC/WT's "Architectural Woodwork Standards."
 - 1. Grade: Custom.
- B. Configuration:
 - 1. Front: Straight, slightly eased at top.
 - 2. Backsplash: Straight, slightly eased at corner.
 - 3. End Splash: Matching backsplash.
- C. Countertops: 3/4-inch- thick, quartz agglomerate.
- D. Backsplashes: 3/4-inch- thick, quartz agglomerate.
- E. Comply with quartz agglomerate manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
 - 1. Fabricate with loose backsplashes for field assembly.
- F. Joints: Fabricate straight countertops eight feet or less in length without joints.

- G. Joints: Fabricate countertops in sections for joining in field, with joints at locations as approved by Architect.
1. Joint Locations: Not within 18 inches of a sink or cooktop and not where a countertop section less than 36 inches long would result, unless unavoidable.
 2. Splined Joints: Accurately cut kerfs in edges at joints for insertion of metal splines to maintain alignment of surfaces at joints. Make width of cuts slightly more than thickness of splines to provide snug fit. Provide at least three splines in each joint.
- H. Cutouts and Holes:
1. Undercounter Plumbing Fixtures: Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.
 - a. Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting 3/16 inch into fixture opening.
 2. Counter-Mounted Plumbing Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
 3. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.

2.4 INSTALLATION MATERIALS

- A. Adhesive: Product recommended by quartz agglomerate manufacturer.
- B. Sealant for Countertops: Comply with applicable requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates to receive quartz agglomerate countertops and conditions under which countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install countertops level to a tolerance of 1/8 inch in 8 feet, 1/4 inch maximum. Do not exceed 1/64-inch difference between planes of adjacent units.
- B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Predrill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with quartz agglomerate manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- C. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.
- D. Secure countertops to subtops with adhesive according to quartz agglomerate manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to

comply with quartz agglomerate manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

- E. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.
 - 1. Install metal splines in kerfs in countertop edges at joints. Fill kerfs with adhesive before inserting splines and remove excess immediately after adjoining units are drawn into position.
 - 2. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.
- F. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
- G. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
- H. Apply sealant to gaps at walls; comply with Section 079200 "Joint Sealants."

END OF SECTION 123661.19

SECTION 124813 - ENTRANCE WALK-OFF CARPET

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Carpet-tile entrance mats.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for floor mats.

B. Shop Drawings:

1. Items penetrating floor mats, including door control devices.
2. Divisions between mat sections.
3. Perimeter floor moldings.

C. Samples: Floor mat, in manufacturer's standard sizes.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance Data: For floor mats to include in maintenance manuals.

1.4 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Carpet-Tile Entrance Mats: Full-size tile units equal to 5 percent of amount installed, but no fewer than 10 units.

PART 2 - PRODUCTS

2.1 ENTRANCE FLOOR MATS, GENERAL

A. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities.

2.2 CARPET-TILE ENTRANCE MATS

A. Carpet-Type Tiles (**CPT-2**): Nylon carpet bonded to premium backing to form mats of manufacturer's standard thickness with nonraveling edges.

1. Product: Milliken; Obex - Cut/Drift
2. Construction: Tufted, cut pile.
3. Fiber: Type 6 and Type 6,6 nylon.
4. Dye Method: Solution dyed.

5. Face Weight: 28 oz/sq. yd.
6. Pile Height: 0.18 inch.
7. Density: 5,281.
8. Tile Size: Nominal 20 by 20 inches.
9. Colors: As indicated on Material Finishes Legend.

- B. Carpet-Type Tiles **(CPT-6)**: Nylon carpet bonded to premium backing to form mats of manufacturer's standard thickness with nonraveling edges.

1. Product: Milliken; Obex - Loop/Bark
2. Construction: Tufted, multi-level loop pile.
3. Fiber: Type 6 nylon.
4. Dye Method: Solution dyed.
5. Face Weight: 28 oz/sq. yd.
6. Pile Height: 0.26 inch.
7. Density: 5,740.
8. Tile Size: Nominal 20 by 20 inches.
9. Colors: As indicated on Material Finishes Legend.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and floor conditions for compliance with requirements for location, sizes, and other conditions affecting installation of floor mats.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Set mat tops at height recommended by manufacturer for most effective cleaning action; coordinate tops of mat surfaces with bottoms of doors that swing across mats to provide clearance between door and mat.
- B. Install units to comply with manufacturer's written instructions at locations indicated; coordinate with entrance locations and traffic patterns.

3.3 PROTECTION

- A. Protect mats until construction traffic has ended and Project is at Substantial Completion.

END OF SECTION 124813

SECTION 210010 – FIRE SUPPRESSION GENERAL

PART 1 - GENERAL

1.1 DESCRIPTION

- A. These fire suppression provisions specified herein apply to all Sections of Division 21.
- B. Refer to the General and Supplementary Conditions and Division 01 for special requirements and conditions which apply to all Sections of Division 21.
- C. This Section includes responsibilities and obligations in support of the performance verification specified in Section 210090, Fire Suppression Performance Verification and general commissioning requirements.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. North Carolina State Fire Prevention Code-2018
 - 2. NFPA 13-2013.
 - 3. NFPA 14-2013.
 - 4. NFPA 20-2013.
 - 5. NFPA 2001-2015.
 - 6. North Carolina State Electrical Code-2017.
- B. Codes, standards and regulations referred to are minimum standards. Where the requirements of these specifications or drawings exceed those of the codes, standards and regulations, the drawings or specifications shall govern.
- C. Fire Suppression/Electrical Design Coordination:
 - 1. The power ratings of motors and other fire suppression equipment and the electrical characteristics of electrical systems serving them, as specified herein and indicated on the Drawings, have been established as minimums which will allow that equipment to satisfactorily function while producing the required capacities. These power ratings include a safety factor deemed appropriate to accommodate common differences between design parameters and field construction practices. Under no circumstances shall equipment with power ratings less than those indicated on the Drawings or specified herein be provided.
 - 2. Reasonable efforts have been made to coordinate the electrical requirements of the fire suppression equipment with the electrical systems serving that equipment. Differences among manufacturers of fire suppression equipment make it impossible to produce a single electrical design which will satisfy the varying electrical requirements of those manufacturers. Consequently, the Contractor shall coordinate the electrical requirements of the fire suppression equipment actually furnished on this Project and provide the electrical systems required by that equipment. This coordination effort shall be completed prior to the installation of either the fire suppression equipment or the electrical systems serving that equipment. Electrical system revisions required to coordinate with the fire suppression equipment actually furnished shall be provided at no additional cost to the Owner.
- D. Low-Emitting Materials
 - 1. Adhesives, sealants, sealant primers, paints, and coatings used inside the building (defined as inside the weatherproofing envelope and applied on-site) shall be tested and determined compliant with California Department of Public Health (CDPH) Standard Method v1.2-2017, using the applicable exposure scenario.

2. Methylene chloride and perchloroethylene shall not be intentionally added in paints, coatings, adhesives, or sealants that are applied on-site.
3. All paints and coatings that are wet-applied on site and used inside the building must meet the applicable VOC content limits of one of the following:
 - a. California Air Resources Board (CARB) 2019, Suggested Control Measure (SCM) for Architectural Coatings
4. All adhesives and sealants that are wet-applied on site and used inside the building must meet the applicable VOC content requirements of SCAQMD Rule 1168, July 1, 2017.
5. All exterior applied adhesives, sealants, coatings, and waterproofing materials must meet VOC content limits of BOTH of the following:
 - a. California Air Resources Board (CARB) 2019 Suggested Control Measure (SCM) for Architectural Coatings
 - b. South Coast Air Quality Management District (SCAQMD), Rule 1168, effective July 1, 2017.
 - c. Small containers of adhesives and sealants subject to state or federal consumer product VOC regulations are exempt.
6. Paint that is applied on site shall not contain lead or any intentionally added cadmium.

1.3 SPACE CONDITIONS

- A. Drawings are diagrammatic in nature and, unless explicitly dimensioned, indicate approximate locations of apparatus, equipment, and piping. Changes in the location, and offsets, of same which are not shown on the Drawings but are necessary in order to accommodate building conditions and coordination with the work of other trades, shall be made during the preparation of coordination drawings and prior to initial installation, without additional cost to the Owner.
- B. Provide access to equipment and apparatus requiring operation, service or maintenance throughout the life of the system.
- C. Piping and equipment shall not be installed in electrical equipment rooms, elevator equipment rooms, or elevator shafts unless specifically indicated on the Drawings. In addition, piping or fire suppression equipment shall not be installed in the space equal to the width and depth of switchgear, switchboards, panelboards, and motor control centers from floor to structure above nor within the working space in front, rear and/or side (where rear and/or side access is required to work on equipment) of electrical equipment (switchgear, switchboards, panelboards, motor control centers, variable frequency drives, transformers, and starters). Dimensions of the working space shall be a minimum depth of 42" horizontally, the width of the equipment or 30", whichever is greater, and the height of the equipment or 78", whichever is greater. Minimum depth shall be increased to 60" for equipment rated over 600 V.

1.4 ASBESTOS MATERIALS

- A. Materials containing asbestos or any trace of asbestos related materials shall not be used on this Project.

1.5 DEFINITIONS

- A. Exposed piping or conduit is that which can be seen when the base building and tenant fit-up is complete without opening or removing access doors or panels or accessible ceiling components.
- B. Other piping and conduit is considered to be concealed.

1.6 RELATED WORK DESCRIBED IN OTHER DIVISIONS

- A. Installation of access panels in wall and ceiling construction.
- B. Cutting, coring, waterproofing, and patching of walls, floors, ceilings, roofs and structure of existing buildings.
- C. Painting, except as specified herein.
- D. Electric power, interlock, and control wiring, except as specified herein.
- E. Installation of starters, contactors, thermal overload switches, and remote push buttons, except as specified herein.
- F. Demolition, including removal of piping and equipment.

1.7 UTILITY CONNECTIONS AND SERVICE

- A. Water:
 - 1. Arrange for connection to the water main, extension of service and installation of a backflow preventer of not less than 6" size. Pay charges in connection therewith.

1.8 SUBMITTALS

- A. After notice to proceed, submit a schedule indicating the proposed submission date of each submittal specified herein. Schedule shall anticipate the submittal review time, the possible need for resubmittals, and the time required for fabrication, shipping and integration into the construction sequence. Architect will advise of any conflicts in reviewing submittals that the proposed schedule presents.
- B. Submittals shall be prepared in a line-by-line format corresponding to these Specifications and shall indicate compliance with each requirement specified herein and indicated on the Drawings.
 - 1. In addition to any other transmittals or cover sheets used, fill out and attach to each individual submittal a copy of the Cover Sheet for Submittals to Newcomb & Boyd included at the end of this Section.
 - 2. Indicate manufacturer's installation instructions.
 - 3. Indicate deviations, if any, including any from the manufacturer's installation instructions.
 - 4. Reproductions or electronic versions of design drawings shall not be used in the preparation of shop drawings.
 - 5. Resubmittals that are required to address review comments shall include a cover transmittal with a written explanation of how each review comment has been addressed.
 - 6. Submittals not specifically required, or not complying with the format requirements, will be returned unreviewed.
 - 7. Shop drawings and submittals shall be provided in portable document format (PDF). PDF files containing multiple drawings or components shall include an index of the file contents and electronic bookmarks.
- C. Shop drawings shall include the following:
 - 1. Trade shop drawings (i.e., fire suppression sprinkler working drawings, clean agent fire suppression working drawings,) shall be submitted within 30 days after award of contract.
 - 2. Approved trade shop drawings shall be utilized as the basis for the coordination drawings. Coordination drawings shall be submitted within 30 days after approval of trade shop drawings.

3. Coordination drawings shall utilize either manual or electronic means of analyzing the work of each trade in spatial relationship with other trades. Locations of conflicts between trades, and the proposed resolution for each conflict, shall be noted on the coordination drawings submitted.
 4. No work shall be fabricated and/or installed prior to receipt by the Contractor of approved trade shop drawings and approved coordination drawings without specific written authorization from the Architect. No change orders will be approved or design assistance provided for remedial field coordination activities for work fabricated and/or installed prior to receipt by the Contractor of approved trade shop drawings and approved coordination drawings.
- D. General submittals shall include the following:
1. Performance Verification Supervisor qualifications.
 2. Coordination drawings, with dimensions and elevations, of plumbing, HVAC, and fire suppression work, including ductwork, equipment, piping with fittings, valves, dampers, accessories and sleeves where applicable according to trade, coordinated with the work of other trades, including HVAC, plumbing, fire suppression, electrical, structural, and architectural, minimum 1/8" = 1'-0" scale.
 3. Seismic restraint devices, including calculations, restraint selection, installation details and written confirmation that a licensed engineer prepared the calculations.
- E. Fire suppression submittals shall include the following:
1. Air compressors and pressure maintenance devices.
 2. Backflow preventers.
 3. Contractor's welders qualification test records.
 4. Deluge valves and trim.
 5. Exterior adhesives, sealants, and coatings that are applied on site.
 6. Final hydraulic calculations based on working drawings, including additional fittings for coordination, and conforming to the format given in NFPA 13-2013.
 7. Fire department connections.
 8. Fire hose valves with adjustment instructions.
 9. Fire pumps and controllers, including performance curves and accessories.
 10. Indicator posts.
 11. Paints, coatings, adhesives, and sealants that are applied on site and inside the building.
 12. Pipe hangers.
 13. Piping and fittings, aboveground.
 14. Sprinkler heads.
 15. Valves.
 16. Valve monitor switches.
 17. Water flow switches.
 18. Water storage reservoirs.
 19. Working drawings, approved and stamped by the insurer's agent prior to pipe fabrication, with pipe lengths, hanger locations, hydraulic reference points, and data required by NFPA 13-2013, minimum 1/4" = 1' - 0" scale.
- F. Clean agent fire suppression system submittals shall include the following:
1. Audible and visible alarms.
 2. Control heads and hoses.
 3. Control panels including modular components, terminal connections, and point-to-point wiring diagrams for external devices.
 4. Door and damper closers.
 5. Flow calculations indicating: hazard area and volume; hazard design temperature; agent concentration and quantity; number, size, and fill weight of storage containers; and pipe sizes and friction losses. ; and nozzle sizes and flow rates.
 6. Manual release and abort switches.
 7. Nozzles and escutcheons.
 8. Pipe and fittings.

9. Remote alarm annunciators.
10. Smoke detectors.
11. Standby batteries.
12. Storage containers and mounting brackets.
13. Working drawings with the location of principal system components and the location of pipe sizing reference points, minimum 1/8" = 1' - 0" scale.

1.9 EQUIPMENT AND INSTALLATION REQUIREMENTS

- A. Equipment and materials shall, unless otherwise specified herein, be new and shall be of the customary standard and quality furnished by the designated manufacturer for that catalogue number.
- B. Materials and equipment shall be UL listed, and shall bear the UL listing mark on products for which standards have been established and for which listing is regularly furnished by UL.

PART 2 - PRODUCTS

2.1 HANGERS AND SUPPORTS

- A. Hangers:
 1. General: complete with rods and supports proportioned to the size of piping or equipment to be supported.
 2. For steel sprinkler and standpipe piping 4" and smaller: galvanized steel, flat band type; Anvil 69, B-Line B3170 NF, or ERICO 115.
 3. For steel sprinkler and standpipe piping larger than 4": galvanized steel, clevis type; Anvil 260, B-Line B3100, or ERICO 401.
- B. Hanger Rods:
 1. One-piece steel type, threaded as required.
 2. Sizes, unless specified otherwise herein, shall be as follows:

<u>Pipe Size</u>	<u>Rod Diameter</u>
2" and smaller	0.375"
2.5" and 3"	0.5"
4"	0.625"
6"	0.75"
8" and larger	0.875"
 3. Sizes for gang or multiple hangers: calculated for the combined weight of the piping and accessories.
 4. Sizes for equipment hangers: calculated for the weight of the equipment supported.
 5. Sizes for sprinkler piping: in accordance with NFPA 13-2013.
- C. Inserts:
 1. Adjustable type: Anvil 282, B-Line B3014, or ERICO 355.
 2. Continuous type: Anvil PS-5000, B-Line B32I, or ERICO CON.
- D. Expansion Anchors:
 1. In concrete: wedge, self-drilling, or drilled flush type.
 2. In masonry: sleeve type.
 3. Manufacturer: Hilti, ITW Ramset/Red Head, or Rawl.
- E. Clamps for piping in bar joist construction: Anvil 92 or 93, B-Line B3031 or B3033, or ERICO 300.

- F. Channel strut systems: 14 gauge minimum galvanized steel, with factory-punched attachment holes. Straps shall be designed so that the attachment nut is captive on the shoulder of the strap when tightened. Attachment nuts shall be designed to provide a surface on the turned down edge while making positive contact with the side walls of the channel. Nuts, bolts, straps, and accessories shall be protected with same finish as channels.

1. Manufacturer: B-Line, Kindorf, Midland-Ross, or Unistrut.

- G. Pipe Stand Supports:

1. For fire suppression water piping: adjustable pipe saddles, stanchion type with locknut nipple, reducer, flange and baseplate. Provide U-bolt yoke for pipe 12" and smaller.

a. Manufacturer: Anvil 264, B-Line B3093, or ERICO 723.

2.2 VALVE TAGS

- A. Minimum 19 gauge polished brass, 1.5" minimum size. Tags shall be octagonal. Stamped numbers and letters shall be not less than 0.75" high, and filled with black paint.

2.3 IDENTIFICATION MATERIALS

- A. Pipe identification shall be 5 mil thick, self-adhering vinyl plastic tape. Tape and legend shall be as follows:

<u>Diameter (Including Insulation)</u>	<u>Width</u>	<u>Size of Legend Letters</u>
0.75 - 1.25"	8"	0.5"
1.5 - 2"	8"	0.75"
2.5 - 6"	12"	1.25"
8 - 10"	24"	2.5"
Over 10"	32"	3.5"

1. Legends shall be in full or abbreviated form, in contrasting color to background color.

- B. Nameplates and signs: laminated plastic, engraved with white letters. Background color shall be:

<u>System</u>	<u>Color</u>
Equipment served by emergency power	Red
Fire suppression systems	Red

2.4 SLEEVES

- A. Sleeves shall be standard weight steel pipe except sleeves for concealed piping through floors not in structural members, and through interior drywall construction may be formed from 26 gauge galvanized sheet metal lapped and pop riveted.

- B. Sleeves through roof slabs for roof manifold valve piping shall be screw type: Josam 26420, Smith 1760, or Zurn Z-197.

2.5 PENETRATION SEALS

- A. Firestops:

1. Refer to Section 078443, Joint Firestopping.

B. Expansion Seals:

1. Waterproof, modular, mechanical expansion type consisting of synthetic rubber grommets or interlocking links shaped to continuously fill the annular space between the penetrating item and the opening. Sizing of links and sleeve shall be determined by the manufacturer.
2. Manufacturer: Calpico Pipe Linx, Metraflex MetraSeal, or Thunderline Link Seal.

2.6 SEISMIC RESTRAINTS

A. Seismic force design shall be determined in accordance with the following seismic design criteria:

1. Seismic Design Category: D.
2. Risk Category: IV.
3. Component Importance Factor, I_p : 1.5.

B. Provide restraint devices as required for fire suppression components. Provide calculations to determine restraint loadings for specific components to be installed resulting from seismic forces on components. Seismic restraint calculations shall be signed by a licensed engineer in the employ of the seismic restraint device manufacturer.

C. Exceptions for fire suppression components listed within the applicable project building code may be utilized. However, use of exceptions shall be noted with submitted seismic restraint calculations.

D. Seismic restraints shall have Anchorage Preapproval "R" Number from OSHPD in the State of California listing minimum certified horizontal and vertical load ratings.

E. Suspended Restraints:

1. Restraints for suspended equipment and components shall consist of steel angle or unistrut with anchor bolts and end connection fittings designed to swivel to the final installation angle.
2. Manufacturer: B-Line, International Seismic Application Technology, Kinetics Noise Control, Mason Industries, Tolco, VMC Group, Vibration Eliminator, or Vibro-Acoustics.

2.7 CONCRETE

A. Normal weight concrete (145 pcf) using Type I Portland Cement, 1" maximum size coarse aggregate to provide a minimum 28 day compressive strength of 3000 psi.

2.8 GROUT

A. Nonshrink type, conforming to ASTM C1107/C1107M-2017 when tested at fluid consistency. Grout shall exhibit zero bleeding at every age when mixed to fluid consistency. Minimum 28 day compressive strength, when mixed to fluid consistency, shall be 7000 psi.

B. Manufacturer: Cormix, or Master Builders.

2.9 ACCESS PANELS - BUILDING

A. Refer to Section 083113, Access Panels.

2.10 ESCUTCHEONS

A. Split hinged type, constructed of chromium-plated steel or cast brass, sized to cover sleeve.

2.11 UNDERGROUND WARNING TAPE

- A. Tape shall be acid and alkali resistant polyethylene film tape, 6" wide with minimum thickness of 0.004", specifically designed for marking and locating of underground utilities.
- B. Tape shall be manufactured with integral wires, foil backing or other means to enable detection by a metal detector when the tape is buried up to 3' deep. The metallic core of the tape shall be encased in a protective jacket or provided with other means of corrosion protection.
- C. Tape color shall be blue and shall bear a continuous printed inscription describing the specific utility.
- D. Manufacturer: Brady, Boddingtons, Carlton Industries, Seton, or Thor Enterprises.

2.12 PAINTING

- A. Paint shall be designed for the temperatures at which the system will operate.

PART 3 - EXECUTION

3.1 PROTECTION OF EQUIPMENT AND MATERIALS DURING CONSTRUCTION

- A. Provide protective covers, skids, plugs or caps to protect equipment and materials from damage or deterioration during construction.
- B. Store equipment and material under cover, and off the ground or floors exposed to rain.
- C. For outdoor storage, protective covers of 10 mil thick black sheet plastic shall be fitted over equipment and materials. Covers shall be reinforced to withstand wind and precipitation. Set equipment and material on skids or platforms of height to avoid damage or deterioration from spattering and ground water.
- D. Plug ends of pipes when work is stopped to prevent debris from entering the pipes.
- E. Provide dust and debris protection for equipment, motors, and bearings operated during construction up to date of the Architect's final certificate.

3.2 EQUIPMENT AND INSTALLATION REQUIREMENTS

- A. Equipment shall be installed and connected as specified herein or indicated on the Drawings in accordance with the manufacturers' instructions and recommendations for this Project. Furnish and install auxiliary piping, water seals, valves, and electrical connections recommended by the manufacturer for operation.
- B. In unfinished areas designated for future build-out, install piping, conduit and equipment tight against the structure to maximize future ceiling height.
- C. Motor quantities, sizes and equipment wattage ratings specified herein or indicated on the Drawings are the minimum requirements, unless noted otherwise. Motor quantities, sizes and equipment wattage ratings less than those specified herein or indicated on the Drawings are not acceptable. Larger motor sizes and equipment wattage ratings may only be provided if necessary to meet the prescriptive requirements specified herein or indicated on the Drawings. Where multiple motors or motor sizes or equipment wattage ratings larger than specified herein or indicated on the Drawings are furnished, provide and coordinate the corresponding increased number or capacity of feeders and other electrical equipment serving them, at no additional cost to the Owner.

- D. Motors and pumps shall be statically and dynamically balanced and shall have steady state radial vibration levels which do not exceed the following:

<u>Equipment</u>	<u>Peak-to-Peak Displacement (mils)</u>
Pumps and motors over 1800 rpm	1
under 1800 rpm	2

- E. Field-installed equipment controls or sensor wiring shall be installed in conduit. Low voltage control and sensor wiring shall be installed in conduits separate from line voltage control wiring and power wiring.
- F. Where water connection sizes at equipment vary from the pipe size indicated on the Drawings, provide appropriate reducers/increasers directly adjacent to the pipe-equipment unions. Unless otherwise specified herein or indicated on the Drawings, the size of the valves and accessories dedicated to the equipment shall not be less than the pipe size to which they are connected.

3.3 HANGERS AND SUPPORTS

- A. Hangers for piping shall be spaced according to NFPA 13-2013.
- B. Where several pipes run parallel and in the same plane:
- 2.5" and smaller: may be supported on gang or multiple hangers. Separate copper tubing from ferrous supports with copper-plated steel or 4 psf sheet lead.
 - 3" and larger: support independently, parallel, and equally spaced.
- C. Supports for steel pipe and for copper tubing, except standpipe piping, 1.25" or larger, shall not be more than 10' apart.
- D. Support piping independently of equipment.
- E. Adjust hangers and supports so that loading is uniform.
- F. Hanger rods shall be suspended from the structure. Do not suspend from other piping, or equipment.
- G. Inserts:
- Use for piping 2.5" and larger in new concrete construction.
 - Where the weight to be supported by an insert exceeds 50% of its rated load, install 2 No. 3 reinforcing rods, 3' long through each yoke of insert.
- H. Where indicated on the Drawings, support piping on pipe stand supports. At the base of each support, weld a slip-on flange to the vertical stanchion. Place stanchion and flange on top of a baseplate, welding the flange to the baseplate. Anchor baseplates to foundations. Provide schedule 40 pipe to increase stanchion height as required by field conditions.
- I. Where fire suppression systems are seismically braced, provide listed restraining straps for C-type clamps used to attach piping hangers to the building structure.

3.4 SLEEVES

- A. Provide where pipes pass through walls, floors and roofs, except in the following circumstances:
- Concealed wall openings of the required diameter in non fire- or smoke-rated construction.

2. Concealed floor openings formed by the use of plastic forming devices providing a circular opening of the required diameter.
 3. Core drilled concealed openings. Openings in roofs shall not be core drilled. Obtain written permission prior to core drilling.
 4. Openings in concrete floor slabs on grade.
- B. Sleeves shall be placed into position prior to wall, floor, or roof construction. Sleeves shall be tight-fitting and cut smooth.
- C. Floor sleeves shall be cast in place, shall be watertight, and shall extend from the bottom of the slab to 2" above the finished floor.
- D. Wall sleeves shall extend 1" on each side of walls.
- E. Make sleeves through outside walls above and below grade watertight.
- F. Sleeves in nonrated construction shall be sized to provide clearance all around pipe, to accommodate thermal movement. Clearance shall be minimum 0.75".
- G. Furnish 4 psf lead flashing for sleeves through flat built-up roofs extending at least 8" from the sleeve in all directions.
- H. For piping designed for future upward extension, provide steel pipe sleeves in the roof slab accurately aligned for future extension of these lines. Fill these sleeves with a removable insulating material and coordinate sealing of sleeve tops with the roofing system.
- I. Where fire suppression systems are seismically braced, sleeves and clearances for all fire suppression piping shall be sized in accordance with the earthquake protection requirements of NFPA 13-2013.

3.5 PENETRATION SEALS

- A. General:
1. Install in accordance with the manufacturer's published instructions to achieve ratings and classifications specified herein. A copy of these instructions shall be maintained and available on site.
- B. Firestops:
1. Close and firestop penetrations through fire- and smoke-rated construction. Materials used to seal these penetrations shall continue the construction's fire and smoke resistance ratings uninterrupted and shall maintain an effective barrier against the spread of flame, smoke, water and hot gases. Install after installation of piping, and conduits.
- C. Expansion Seals:
1. Use expansion seals between pipes and sleeves. Where walls exceed the width of expansion seals, use two seals, one being flush with the inside sleeve face and the second with the outside sleeve face. Fill the annular void space between the two seals.

3.6 IDENTIFICATION OF PIPING

- A. Identify piping specified under this Division in accordance with ASME A13.1-2015.

- B. Legends shall be on the lower quarters of the pipe except where such location would be obscured. Arrow tape shall be wrapped completely around the pipe at each end of the legend with arrows pointing in the direction of flow.
- C. Locate pipe identification as follows:
1. Mechanical equipment rooms:
 - a. Within 18" of each valve or valve assembly.
 - b. Within 36" of each 90° elbow, connection to equipment, point where pipe enters shafts and pierces outside walls.
 - c. On not over 20' intervals along exposed piping.
 2. Above suspended ceilings: and below raised floors:
 - a. Within 18" of each valve or valve assembly.
 - b. At tees within 36" of both main and branch.
 - c. Within 36" of each 90° elbow.
 - d. On not over 20' intervals.
 3. Piping concealed in chases or shafts:
 - a. Each pipe visible through an access door or panel.
 4. Piping exposed in rooms other than mechanical equipment areas:
 - a. Omit identification of sprinkler piping.
 - b. With the above exception, identify at not less than 1 point each piping run visible in each room with identification on not over 20' intervals.
- D. Schedule of Piping Identification:

<u>Piping System and Contents</u>	<u>Tape Color</u>	<u>Legend</u>	<u>Abbreviated Legend</u>
Fire Suppression	Red	Fire Line	Fire
Clean Agent	Red	Clean Agent	CA

3.7 VALVE TAGS AND SCHEDULES

- A. Provide numbered brass tags on valves. Attach tags to valve stems with brass S-hooks or brass chain.
- B. Tags on new valves shall continue the numbering sequence of existing valves.
- C. Provide for each system a typewritten schedule of valves giving number, location (room number), and function of each with a small scale diagram outlining general piping layout and location of each numbered valves.

3.8 IDENTIFICATION OF EQUIPMENT

- A. General:
1. Identification shall consist of upper case letters.

2. Each starter, contactor, push button station, control switch, disconnect, and thermal overload switch shall be appropriately identified by nameplates with 0.25" high letters.
 - a. Identification shall include the equipment designation and device function, e.g., FPC-1 Fire Pump Controller.

B. Clean Agent Fire Suppression:

1. Provide a sign near each entrance into the area to alert personnel that the room is protected by a clean agent fire suppression system, that doors should be kept closed during a fire, and that nonemergency personnel should leave the area prior to agent release.
2. Provide identification signs at alarm devices, release stations, and abort switches.

3.9 EQUIPMENT AND EQUIPMENT ROOMS

- A. Remove dust, dirt, rust, stains, and temporary covers.
- B. Foreign matter shall be blown, vacuumed, flushed, or cleaned out of and from new equipment, piping, pumps, motors, bearings, devices, switches, controls, and panels.
- C. Clean and polish identification plates.
- D. In equipment rooms, clean equipment, piping, conduit, and room surfaces from dust and dirt and maintain in a clean condition from date of the Architect's final certificate until final completion of work and corrective work.
- E. Remove excess material from the Project site.

3.10 SEISMIC RESTRAINTS

- A. Restraints shall be installed after the equipment is mounted, piped, connected, and operating to ensure that no contact occurs during normal equipment operation.
- B. Installation of seismic restraints shall not cause any change of position of equipment or components resulting in stress and misalignment.
- C. Do not brace a system to two different structures, such as a wall and a ceiling.
- D. After installation, manufacturer shall verify that seismic restraints are installed and operating properly, and shall submit a certificate so stating.

3.11 FOUNDATIONS

- A. Provide concrete foundations for the following floor-mounted equipment:

<u>Fire Suppression Equipment</u>	<u>Foundation</u>
Fire pumps	4" high pad
Jockey pumps	4" high pad

1. Foundation height shall accommodate seismic anchors, but shall be not less than the minimum specified above.

- B. Foundations shall be continuous and shall have beveled edges and smooth float finish. Foundations shall be reinforced with No. 3 bars a maximum of 12" on center each way, and held in place with dowel rods at each corner anchored in the slab. Dowel rods shall not penetrate through the slab.
- C. Roughen and clean exposed slabs before pouring foundations. Apply bonding agent to surfaces in contact.
- D. Foundations shall extend a minimum of 6" beyond the equipment footprint or 1.5 times seismic anchor embedment depth from the point of anchoring (whichever is larger) in all directions, including appurtenances, base elbow supports, and motors.
- E. Equipment attached directly to foundations; bases provided with grout holes; and bases consisting of a structural frame shall have voids filled with grout after attachment to foundation.
- F. Fill voids between baseplates and foundations, and level equipment, with grout.

3.12 ACCESS PANELS - BUILDING

- A. Where fire suppression work is concealed by walls or ceilings, or is inaccessible, provide an access panel to provide access for service and maintenance.
- B. Fire suppression work located above ceilings is considered accessible if the ceiling is the accessible type and is arranged for access to the equipment.
- C. Fire-rated access panels shall be provided in fire barriers with ratings to match the construction fire rating.
- D. Installation of access panels is specified under another Division.

3.13 ESCUTCHEONS

- A. Provide escutcheons where exposed piping passes through walls, floors and ceilings in finished areas.

3.14 UNDERGROUND WARNING TAPE

- A. During backfill, install tape continuously along length of piping, 12" to 18" above the fire suppression piping.

3.15 PAINTING

- A. Except where otherwise specified herein, painting shall be done under another Division. Surfaces shall be left clean and free from oil.
- B. Equipment factory finishes damaged or deteriorated during construction shall be repaired to match original finish.
- C. Where galvanizing is broken during fabrication or installation, recoat exposed areas with zinc-rich paint.
- D. Exterior ferrous equipment, piping and supports shall be painted with 2 coats of rust preventive paint, color selected by the Architect.
- E. Interior uninsulated black steel piping, and nongalvanized ferrous accessories, hangers, rods, inserts, and mechanical supports shall be prepared and painted with 1 coat of rust preventive paint prior to other painting or identification, or 2 coats of rust preventive paint if no other painting is specified.

- F. Conduits and pipe visible through architectural return air openings, grilles, registers and diffusers shall be painted flat black.

3.16 COORDINATION

- A. Provide offsets, transitions, and fittings to coordinate the work of each trade with that of other trades, including HVAC, plumbing, fire protection, electrical, structural, and architectural.

3.17 OPERATION AND MAINTENANCE MANUALS

- A. These operation and maintenance manual requirements supplement operation and maintenance manual documentation requirements of other Sections of these specifications.
- B. Operation and maintenance documentation, in hardback 3-ring loose-leaf binders except full size drawings and diskettes, shall cover the fire suppression systems. Documentation shall include an operation and maintenance documentation directory, emergency information, operation manual, maintenance manual, test reports, and construction documents.
- C. The operation and maintenance documentation package shall be submitted as one comprehensive package to the Architect 3 months before systems start-up, and shall be updated, revised and completed at completion of, construction.
- D. Compile and coordinate the documentation for equipment and systems installed. Documentation shall be typewritten and shall contain, at a minimum, the following information.
 - 1. Introduction:
 - a. Project name, contractors' and subcontractors' names, addresses, and telephone and facsimile numbers.
 - b. Index.
 - 2. Operation and Maintenance Documentation Directory:
 - a. Explanation of the identification system used, including lists of systems, equipment, and component identifiers and names.
 - 3. Emergency Information:
 - a. Information for technical and nontechnical personnel about actions recommended during emergency situations to protect life and property and to minimize disruption to the building occupants. Emergencies shall, at a minimum, include:
 - 1) Fire.
 - 4. Operation Manual:
 - a. General Information:
 - 1) Building function.
 - 2) Building description.
 - 3) Operating standards and logs.
 - b. Technical Information:
 - 1) System description.
 - 2) Operating routines and procedures.
 - 3) Special procedures.
 - 4) Basic troubleshooting.
 - 5. Maintenance Manual:

- a. Descriptions (specifications) of the equipment and components.
 - b. Description of function, as applicable: the function of the equipment, procedures before start-up, functional parameters (input, output) at the design load and at part loads, and performance verification procedures.
 - c. Recommended maintenance and lubrication procedures and their recommended frequency for this Project.
 - d. Recommended list of spare parts, part numbers, and the place(s) from which they can be obtained.
 - e. Original purchase order number; date of purchase; name, address, and the telephone number of the vendor; and warranty information.
 - f. Installation information.
 - g. Other information needed for the preparation of documents supporting the management of operation and maintenance programs.
 - 6. Test Reports and Certifications:
 - a. Copies of tests and certifications performed during manufacture and construction, including but not limited to the following:
 - 1) Receipt for instruction of operating personnel.
 - 2) Certification of seismic restraints.
 - 3) Contractor's Material and Test Certificate for Underground Piping per NFPA 24-2013.
 - 4) Contractor's Material and Test Certificate for Aboveground Piping per NFPA 13-2013.
 - 5) Manufacturer's certified fire pump shop test curve.
 - 6) Fire pump acceptance test report.
 - 7) Certification that pressure restricting and pressure reducing equipment is installed and adjusted per NFPA and manufacturers' requirements.
 - 8) Clean agent system enclosure integrity and functional test report.
 - 9) Receipt for instruction of operating personnel on clean agent fire suppression.
 - 7. Construction Documents:
 - a. Record drawings.
 - b. Approved submittals, including revised shop drawings indicating as-installed conditions.
 - c. One copy of shop drawings bearing insurance company approval stamps.
 - d. Equipment identification charts and schedules.
 - e. Warranty certificates.
 - f. Inspection certificates.
 - g. Performance verification report.
 - E. Submit a receipt signed by the Owner acknowledging receipt of the operation and maintenance documentation package.
 - F. Provide metal cabinets mounted on the wall of the Fire Pump Room to house the operation and maintenance documentation package. Cabinets shall be approximately 12" wide x 18" high x 6" deep constructed of 18 gauge sheet metal with hinged door with latch. Cabinets shall be painted black and shall be labeled with 0.5" stenciled letters.
- 3.18 RECORD DRAWINGS
- A. Refer to Section 017839, Project Record Documents.
 - B. A record of field and as-installed conditions shall be maintained at the site, shall be kept current throughout the Project, and shall be used in the preparation of the final record drawings. Field and as-installed

conditions shall be recorded on design drawings and shall be marked to include addenda, change orders, field changes and selections made during construction.

- C. Concurrent with the Architect's final certificate, submit 2 sets of prints indicating field and as-installed conditions of piping and equipment, and incorporating changes made during construction.
- D. Upon completion of the Project, submit marked-up design drawings indicating field and as-installed conditions, and shop drawings incorporating changes made during construction for piping and equipment. Submit the following:
 - 1. 2 sets of bound prints.
 - 2. Full size PDFs on CDs.

3.19 DIAGRAMS

- A. Frame and mount the following information:

<u>Information</u>	<u>Location</u>
Clean agent fire suppression system operating sequence and reset procedures.	Adjacent to control panel.

- B. Diagrams shall be type written or computer generated.
- C. Diagrams shall be as-built, and shall include interfaces and interlocks with other equipment.
- D. Diagram framing system: 0.125" thick acrylic with satin finish aluminum frames.

3.20 MAINTENANCE

- A. Equipment operated prior to the date of the Architect's final certificate shall be maintained in accordance with manufacturer's recommendations.
- B. Prepare and submit a lubrication chart listing for each piece of equipment:
 - 1. Points requiring lubrication.
 - 2. Recommendations for a single manufacturer's lubricants with brand name and designation.
 - 3. Frequency of lubrication required.
- C. Lubricate each item of apparatus requiring lubrication prior to start-up in accordance with the manufacturer's recommendations.

3.21 INSTRUCTION OF OPERATING PERSONNEL

- A. Provide the designated Owner's personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of equipment specified in Division 21. Conduct 2 formal instruction sessions for operating personnel. The first session shall be conducted at the time of start-up and check-out, and the second session shall be approximately 2 months later. Sessions shall be a minimum of 2 days for basic systems, and as specified herein. Sessions shall be conducted at the site.
- B. Prepare and submit a syllabus describing an overview of the proposed training program, describing how the training program will be conducted, when and where meetings are to be held, names and company affiliations of lecturers, description of contents and outline for each lecture, and recommended reference

material and outside reading. Obtain direction from the Architect on which operating personnel shall be instructed in each system. Proposed training schedules, materials, and lesson plans shall be submitted to the Owner for review of the content and adequacy of the training of the Owner's personnel.

- C. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor, or manufacturer's representative. More than one party may be required to execute the training. The training program shall include the following, as appropriate for the system or equipment:
1. Training shall normally start with classroom sessions followed by hands-on training for each piece of equipment, which shall illustrate the various modes of operation, including start-up, shutdown, fire/smoke alarm modes, and power failure.
 2. During any demonstration, should the system fail to perform in accordance with the requirements of the operation and maintenance manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
 3. Attend training sessions for each type of equipment or system controlled by the automation system, to discuss the interaction of the automation system as it relates to the equipment or system, in addition to the training required for the automation system.
 4. Training shall include:
 - a. Use of the printed installation, operation and maintenance instruction material included in the operation and maintenance manuals.
 - b. A review of the written operation and maintenance instructions emphasizing safe and proper operating requirements, preventative and routine maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover, and any emergency procedures.
 - c. Discussion of relevant health and safety issues and concerns.
 - d. Discussion of warranties and guarantees.
 - e. Common troubleshooting problems and solutions.
 - f. Explanatory included in the operation and maintenance manuals and the location of plans and manuals in the facility.
 - g. Discussion of any peculiarities of equipment installation or operation.
 - h. Classroom sessions shall include the use of multimedia instruction material as appropriate.
 - i. Specific operating and maintenance procedures for:
 - 1) Clean agent fire suppression systems, including emergency procedures, abort functions, and safety requirements.
 5. Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment.
 6. Explain and demonstrate the operation, function and overrides of local packaged controls not controlled by the central control system.
 7. Training shall occur after testing is complete, unless approved otherwise by the Architect.
 8. Provide DVD format video recordings of training sessions and a complete record copy of training materials, handouts, and other printed materials used in each training session.
 9. Obtain a receipt acknowledging completion of each item of instruction.

END OF SECTION 210010

COVER SHEET FOR
SUBMITTALS TO NEWCOMB & BOYD

Project: _____ Date: _____

Item: _____ Submittal Number: _____

Manufacturer: _____ Model: _____

Specification Paragraph and/or Drawing Number: _____

Capacity: _____

Electrical Characteristics (including identification of all separate connections or services required): _____

Accessories: _____

Options: _____

Deviations (if any; if none, state so): _____

General Contractor Approval: _____

SECTION 210090 – FIRE SUPPRESSION PERFORMANCE VERIFICATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other fire suppression systems are specified in other Sections of Division 21.
- B. Performance verification is an ongoing process and shall be performed throughout construction. Performance verification verifies that systems are operating in a manner consistent with the Construction Documents.
- C. This Section covers fire suppression systems performance verification, as required to demonstrate that the equipment and systems of Division 21 are ready for safe and satisfactory operation, as defined by the Construction Documents. Performance verification shall include, but shall not be limited to, identification of piping and equipment, cleaning, lubrication, start-up, check-out, and testing, adjusting, and balancing of systems, preparation of equipment and systems documentation and of operation and maintenance manuals, Owner training, and preparation of record drawings.
- D. The general requirements of the commissioning process and the duties of the Commissioning Authority are detailed in Section 290010, Commissioning. Become familiar with the requirements and coordination obligation of Section 290010, Commissioning and the commissioning schedule issued by the Commissioning Authority as they apply to the work of Division 21, and execute the performance verification responsibilities within the commissioning process as specified therein.
- E. Performance verification shall conclude with the completion of required deferred testing, training, and system documentation as specified herein and required to demonstrate the proper operation of the fire suppression equipment and systems provided by this Division.
- F. Verify, at a minimum, the performance of the following systems and equipment and witness the following tests:
 - 1. Section 210010, Fire Suppression General:
 - a. Seismic restraints.
 - 2. Section 213000, Fire Suppression Systems:
 - a. Aboveground pipe.
 - b. Air compressors.
 - c. Alarm and supervisory devices.
 - d. Deluge valves.
 - e. Fire pumps and controller.
 - 3. Section 213500, Clean Agent Fire Suppression Systems:
 - a. Control panels.
 - b. Discharge warning signals.
 - c. Door holders.
 - d. Enclosure integrity and functional tests.
 - e. Extinguishing systems.
 - f. Manual release stations.
 - g. Prealarm (first stage alarm) devices.
 - h. Predischage alarm devices.
 - i. Release abort switches.
 - j. Remote annunciators.
 - k. Smoke detectors.

1.2 QUALITY ASSURANCE

- A. Provide a Fire Suppression Performance Verification Supervisor with ten years experience in fire suppression contracting. The Fire Suppression Performance Verification Supervisor shall become familiar with the Owner's project requirements and the requirements of the performance verification process as defined in this Section and if applicable, the commissioning process defined in Division 29. The Fire Suppression Performance Verification Supervisor shall coordinate and execute the required performance verification activities.
- B. The Fire Suppression Performance Verification Supervisor shall review submittal data for conformance with the requirements of the Project, shall monitor compliance with the requirements specified herein for storage and protection of equipment during construction, shall authorize the initial starting of equipment and systems in a manner to avoid damage to equipment, shall oversee start-up, testing and balancing, and shall document that the scheduled and specified performance requirements of each system have been accomplished.
- C. Refer to ASHRAE Guideline 0.2-2015, Commissioning Process for Existing Systems & Assemblies, and Guideline 4-2019 Preparation of Operating and Maintenance Documentation for Building Systems.

1.3 PERFORMANCE VERIFICATION RESPONSIBILITIES

- A. The Fire Suppression Performance Verification Supervisor shall be responsible for scheduling, supervising, and coordinating and executing the start-up, testing, and performance verification activities as specified herein. Include and itemize the cost of performance verification in the contract price, and in each purchase order or subcontract written, include requirements for submittal data, performance verification efforts and documentation, operation and maintenance data, and training as specified herein.
- B. Fire suppression performance verification shall take place in three phases. Performance verification requirements for each phase are as follows:
 - 1. Construction Phase:
 - a. Attend a performance verification scoping meeting and additional such meetings, initially scheduled monthly until prefunctional testing of equipment and systems begins, and weekly thereafter during the construction phase to facilitate the performance verification process. The Fire Suppression Performance Verification Supervisor shall coordinate meeting attendance with the Commissioning Authority.
 - b. Report in writing to the Architect, at least as often as performance verification meetings are scheduled, concerning the status of fire suppression activities as they affect the performance verification process, the status of each discrepancy identified the prefunctional and functional testing process, explanations of any disagreements with the identified deficiencies, and the proposed resolution and schedule for correction of the deficiency.
 - c. Provide documentation of installed systems and equipment and develop functional testing procedures. This documentation shall include detailed manufacturer installation, start-up, operating, troubleshooting and maintenance procedures; full details of any Owner-contracted tests; pump curves; full factory testing reports, if any; and full warranty information, including responsibilities of the Owner to keep the warranty in force. In addition, the installation, start-up and check-out materials that are actually shipped inside the equipment and the actual field check-out sheet forms to be used by the factory or field technicians shall be submitted to the Architect.
 - d. Develop and submit to the Architect for review and comment, prior to equipment or system start-up, a complete start-up and initial check-out plan using manufacturer's start-up procedures and prefunctional checklists for the performance of the equipment to be verified.
 - e. Assist in clarifying the proposed operation and control of equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.

- f. Prepare the specific functional test procedures as specified herein and review the proposed functional test procedures to ensure feasibility, safety, and equipment protection, and provide necessary written alarm limits to be used during the tests. Obtain Architect approval for proposed functional test procedures.
 - g. Prepare a preliminary schedule for performance verification activities, including pipe pressure and leakage testing, flushing and cleaning, equipment start-up, and testing and adjusting start and completion, and update the schedule during the construction period, as appropriate. Notify the Architect immediately when the performance verification activities not yet performed or not yet scheduled will delay construction.
 - h. Fire suppression equipment start-up shall not be initiated until completion of pressure and leakage testing and cleaning as specified in other Sections of Division 21.
 - i. Provide start-up and prefunctional testing for equipment and execute the fire suppression-related portions of the prefunctional checklists for the verification of the performance of all the equipment during the start-up and initial check-out process.
 - j. Perform and document start-up and system operational check-out procedures, providing a copy to the Architect.
 - k. Correct noncompliance items before beginning functional performance testing.
- 2. Acceptance Phase:
 - a. Place equipment and systems into operation and continue their operation during each working day of the testing and performance verification activities, as required.
 - b. For each system or area, have required prefunctional checklists, calibrations, start-up and prefunctional tests of the fire suppression systems and associated controls completed prior to beginning the testing and adjusting process.
 - c. Provide skilled technicians to execute starting and prefunctional testing of equipment and to execute the functional tests for each individual piece of equipment and system. Technicians shall be available and present during the agreed upon scheduled tests and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
 - d. Perform functional testing for specified equipment and interpret the test data, as necessary, under the direction of the Commissioning Authority.
 - e. Correct deficiencies (differences between specified and observed performance) as identified by the Fire Suppression Performance Verification Supervisor or the Commissioning Authority and interpreted by the Architect and retest the equipment, as required to demonstrate proper operation and performance.
 - f. Prepare operation and maintenance manuals as specified herein, including clarifying and updating the original sequences of operation to as-built conditions.
 - g. Maintain marked-up record drawings and produce final record drawings of Project drawings and contractor-generated coordination drawings.
 - h. Provide specified training of the Owner's operating personnel.
 - i. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
- 3. Warranty Period:
 - a. Execute deferred functional testing.
 - b. Correct deficiencies and make necessary adjustments to operations and maintenance manuals and as-built drawings system or equipment modifications made during the warranty period and those identified in any deferred functional performance testing.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Standard testing equipment required to perform start-up, initial check-out, prefunctional, and required functional testing shall be provided for the equipment or system being tested.

- B. Test equipment shall be of the quality and accuracy required to test and/or measure system performance with the tolerances specified and shall have been calibrated within the last 12 months, or as specified herein. Equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates available on request.
 - 1. Temperature sensors and digital thermometers shall have a certified calibration within the past 12 months and a resolution of $\pm 0.1^{\circ}\text{F}$. Accuracy of temperature test equipment shall be at least twice that of the instrumentation being tested.
 - 2. Pressure sensors shall have a certified calibration within the 12 months and a resolution of 0.05% of sensor range. Accuracy of pressure test equipment shall be at least twice that of the instrumentation being tested.
 - 3. Accuracy of other sensors shall be at least twice that of the instrumentation being tested.

PART 3 - EXECUTION

3.1 SUBMITTALS

- A. Submit additional documentation as required to support the performance verification process. This additional submittal documentation shall include, at a minimum, the proposed start-up and initial check-out procedures, and prefunctional checklists.

3.2 START-UP PLAN AND PREFUNCTIONAL TESTING

- A. Prefunctional testing shall be required for each piece of equipment to ensure that the equipment and systems are properly installed and ready for operation, so that functional testing may proceed without delays. Follow the approved start-up, initial check-out, and prefunctional testing procedures. Sampling strategies shall not be used for prefunctional testing. The prefunctional testing for equipment and subsystems of a given system shall be successfully completed and documented prior to functional testing of the system.
- B. Procedures for performance verification shall include:
 - 1. Start-up and initial check-out plan: develop the detailed start-up and prefunctional testing plans for equipment and systems that are to be performance verified, as specified herein. Review the proposed procedures and prefunctional testing documentation to ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed.
 - 2. The start-up and initial check-out plan shall consist, as a minimum, of the following:
 - a. The manufacturer's standard written start-up and check-out procedures copied from the installation manuals and manufacturer's normally used field check-out sheets. The plan shall include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan.
 - b. First-run checklist for equipment, including:
 - 1) Equipment properly set.
 - 2) Alignment of shafts and couplings.
 - 3) Piping and equipment properly connected.
 - 4) Completion of initial lubrication procedures.
 - 5) Wiring properly connected.
 - 6) Electrical overload relays appropriate for load.
 - 7) Electrical accessories properly installed and adjusted.
 - 8) Controls, safeties, and time switches properly set.
 - 9) Verification of direction of motor rotation after final electrical connections by jogging motor.

- 10) Measurement of ampere draw of electric motors and comparison with nameplate rating and with overload heater ratings.
 - 11) Monitoring of temperature build-up in motors and bearings.
 - c. Contractor-developed prefunctional checklists.
 - 3. Identify which trade is responsible for executing and documenting each of the line item tasks and note that trade on the form. Each form may have more than one trade responsible for its execution.
- C. Four weeks prior to start-up, schedule equipment and systems start-up and check-out and notify the Architect in writing. The execution of the prefunctional checklists, start-up and check-out shall be directed and performed by the Contractor, in accordance with manufacturer's published procedures. The Architect shall be present for the start-up, check-out, and prefunctional testing of the first unit of each type of equipment, and any other tests he designates.
- D. Sensor calibration: calibration of sensors associated with a given piece of equipment or system shall be included as part of the prefunctional testing and listed on the appropriate test checklists and reports for the system.
- E. Completed start-up, check-out, and prefunctional test forms shall be completed and submitted to the Architect for review. List outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies shall be provided to the Architect within 2 days of test completion. The Architect shall review the Contractor's start-up and prefunctional testing reports and shall submit either a noncompliance report or an approval form to the Contractor. The Contractor shall correct items that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the Architect as soon as outstanding items have been corrected and resubmit an updated start-up report and a statement of correction on the original noncompliance report. When requirements are completed, the Architect shall recommend approval of the start-up and prefunctional testing of each system and schedule the functional testing of the equipment or system.
- F. Complete start-up and prefunctional testing for a system before functional test of that system may proceed.
- 3.3 RETESTING OF EQUIPMENT AND/OR SYSTEMS
- A. Provide labor and materials required for retesting of any functional test found to be deficient.
- B. Prior to retesting, submit required data indicating that the deficient items have been completed and/or corrected to the Architect for approval and rescheduling of the functional test. If during the retesting it becomes apparent that the deficient items have not been completed and/or corrected as indicated in the data provided by the Contractor, the retesting shall be stopped. Costs for the design team to further supervise the retesting of a functional test shall be the responsibility of the Contractor.
- 3.4 DEFERRED TESTING
- A. Schedule and coordinate, with the approval of the Architect, tests delayed until building construction is completed, required building occupancy or loading, or other conditions are suitable for the demonstration of equipment or system's performance, as specified herein. Deferred testing shall be executed, documented, and deficiencies corrected as specified herein for functional testing.
- 3.5 TESTING DOCUMENTATION, NONCONFORMANCE, AND APPROVALS
- A. List outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the functional test procedure forms or on an attached sheet. The functional

test procedure forms and any outstanding deficiencies shall be provided to the Architect within 2 days of test completion. The Architect shall review the Contractor's start-up and prefunctional testing documentation and shall submit either a noncompliance report or an approval form to the Contractor. Work with the Architect to correct and retest deficiencies or uncompleted items. Correct items that are deficient or incomplete in a timely manner and notify the Architect as soon as outstanding items have been corrected and resubmit an updated start-up report and a statement of correction on the original noncompliance report. When requirements are completed, schedule the functional testing of the equipment or system.

- B. As functional performance testing progresses and deficiencies are identified, work with the Architect to resolve the issues.

3.6 OPERATION AND MAINTENANCE MANUALS

- A. The Fire Suppression Performance Verification Supervisor shall compile and prepare documentation for equipment and systems covered in Division 21 and deliver this documentation for inclusion in the operation and maintenance manuals prior to the training of the Owner's personnel.

3.7 INSTRUCTION OF OPERATING PERSONNEL

- A. The Fire Suppression Performance Verification Supervisor shall schedule, coordinate and assemble, and deliver the documentation of training required by Division 21.

3.8 FUNCTIONAL TESTS

- A. Functional test requirements for the demonstration of proper system and equipment operation shall be defined by the Fire Suppression Performance Verification Supervisor. Execution of these test and demonstration of the required performance shall be the responsibility of the Contractor.
- B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or subsystems at the discretion of the Fire Suppression Performance Verification Supervisor. Beginning system testing before full completion of construction shall not relieve the Contractor from fully completing the system, including prefunctional checklists.
- C. Functional testing shall be completed, and test documentation approved by the Architect before the Project will be considered substantially complete.

END OF SECTION 210090

SECTION 213000 – FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other fire suppression systems are specified in other Sections of Division 21.
- B. This Section covers the fire sprinkler and standpipe systems.
- C. Clean agent fire suppression systems are specified in Section 213500, Clean Agent Fire Suppression Systems.
- D. The building shall be protected by a combined system of Class I wet standpipes and automatic sprinklers as defined by NFPA 13-2013 and NFPA 14-2013.
- E. This Section includes responsibilities and obligations in support of the performance verification specified in Section 210090, Fire Suppression Performance Verification, and general commissioning requirements.

1.2 QUALITY ASSURANCE

- A. Products and components installed in the system shall be listed by Underwriters Laboratories (UL).
- B. Fire suppression systems shall be installed by a company regularly engaged in the installation of sprinkler systems and which holds a current sprinkler contractor's license from the State of North Carolina. Submittals shall bear the stamp or the license number of the installing contractor.
- C. Unless indicated otherwise on the Drawings, materials shall be new and free from defects.
- D. Materials and equipment used for similar applications shall be the products of one manufacturer.
- E. Shop drawings shall be prepared under the supervision of a NICET Level IV technician certified in Fire Protection Engineering Technology Water-Based Systems Layout. Submittals, drawings, and hydraulic calculations shall bear the NICET technician's certification number.
- F. Minimum service pressure rating for aboveground pipe, valves, and fittings shall be 175 psig unless otherwise specified herein or indicated on the Drawings.

1.3 BASIS OF DESIGN

- A. Obtain a current fire hydrant waterflow test at the site. The test shall be made in accordance with NFPA 13-2013 and shall indicate normal static pressure conditions, residual pressure, and flow rate. Also, obtain a current 24 hour static pressure recording at the site. The waterflow test shall be adjusted downward to reflect any low pressure condition with a duration exceeding 30 minutes during the 24 hour period. Pay all charges and fees associated with these tests.
- B. Hydraulic calculations shall include a minimum safety factor of 15 psig.
- C. Shop drawings and calculations shall show hydraulic reference points from the source to the remote design areas and shall indicate losses for meters and backflow preventers.
- D. Sprinkler spacing shall not exceed 225 ft² for Light Hazard areas and 130 ft² for Ordinary Hazard areas.

- E. The Contractor shall develop coordinated installation shop drawings and hydraulic calculations including the following:
 - 1. Site plan showing location of water supply, underground water lines and valves, water flow test data, location of test hydrants, and relative elevations.
 - 2. Reflected ceiling plan showing the location and type of sprinkler heads mounted on the ceiling.
 - 3. Piping plans showing offsets, pipe elevations, sizes, and lengths; hangers types and locations; seismic restraint locations and types; hydraulic calculation reference points; remote area location; and the volumetric capacity of dry pipe and preaction systems.
 - 4. Hydraulic calculations shall be performed by a computer calculation program specifically designed for the analysis of fire sprinkler systems. Calculations shall use the area/density method described in NFPA 13-2013.
- F. System design densities and remote area of sprinkler operation shall be as indicated on the Drawings.

PART 2 - PRODUCTS

2.1 ABOVEGROUND PIPE AND FITTINGS

- A. Steel pipe: black steel conforming to ASTM A53/A53M-2018, ASTM A135/A135M-2019 or ASTM A795/A795M-2013. Use galvanized pipe where indicated on the Drawings or specified herein. Piping 2" and smaller shall be schedule 40. Dry system piping 2.5" and larger shall be schedule 40. Wet system piping 2.5" and larger shall be schedule 10 conforming to NFPA 13-2013.
 - 1. Use galvanized pipe for dry pipe and preaction systems, compressed air trim, drains subject to alternate wetting and drying, and water motor piping.
- B. Cast iron fittings: standard weight fittings shall be UL classified for 175 psig. Fittings shall comply with ASTM A126-2004 (2019). Threaded fittings shall comply with ASME B16.4-2016. Flanged fittings shall comply with ASME B16.1-2015. Gaskets for flanged fittings shall be full-face type of red sheet rubber. Fittings on galvanized piping systems shall be galvanized.
- C. Welding fittings: UL listed and class 150 factory-fabricated welded outlets, with foundry mark. No other type of welded outlet shall be used.
- D. Grooved couplings and fittings: grooved mechanical fittings and couplings using an elastomeric gasket enclosed by a ductile iron housing. Fittings and couplings on dry piping systems shall be cut-grooved type. Ductile iron shall comply with ASTM A536-1984 (2019)e1. Self-grooving couplings and fittings employing set screws or plain end pipe shall not be used. Segment-welded fittings shall not be used. Fittings on galvanized piping systems shall be galvanized.

2.2 VALVES

- A. Valve size, working pressure, and the manufacturer's name or trademark shall be permanently affixed to valve bodies. Drain, test and gauge valves are exempt from this requirement.
- B. Indicating control valves shall be the OS&Y gate or indicating butterfly type.
- C. Valves for service pressure up to and including 175 psig:
 - 1. Gate valves smaller than 2.5" shall be UL listed OS&Y (rising stem) design with bronze body and mountings, and threaded connections.
 - 2. Gate valves 2.5" and larger for above ground service shall be UL listed OS&Y (rising stem) design with cast iron body, bronze mountings and flange connections. Open counterclockwise.

3. Indicating butterfly valves: UL listed, FM approved, with cast iron body, bronze mountings, flange or groove connections, integral tamper switch, and handwheel operator.
4. Check valves smaller than 2.5" shall be Y-pattern clapper type with renewable seat and disc, bronze body, and threaded connections. Minimum water working pressure 200 psig.
5. Check valves 2.5" and larger shall be UL listed clapper type with cast iron body and bronze mountings, rubber faced disc, flanged connections and bolted access bonnet.
6. Trim valves: gate, globe, angle, and check valves used for trim shall have bronze construction and threaded connections, with a minimum 200 psig working pressure.
7. Pressure relief valves: UL listed, field-adjustable type to maintain constant pressure on the discharge side of the fire pump regardless of demand changes by relieving excess system pressure. Working inlet pressure shall be 175 psig maximum. Body shall be cast iron. Valve shall be hydraulically operated, pilot-controlled, diaphragm type. Valves shall reseal driptight within 5% of the pressure setting. Valves shall be sized in accordance with NFPA 20-2013 based on rated fire pump capacity.

2.3 FIRE PUMPS AND CONTROLLERS

- A. The fire and jockey pumps, drivers, controllers, and accessories shall be purchased from a single supplier. The supplier shall conduct two field tests of the fire pump system as specified herein.
- B. Fire pumps: UL listed horizontal split case, double-suction, cast iron, bronze-fitted centrifugal type. Maximum allowable shutoff (churn) pressure at no flow shall be 120% of rated pressure.
 1. Manufacturer: Allis-Chalmers, Aurora, Fairbanks, Patterson, or Peerless.
- C. Drivers: the pump shall be directly connected through a coupling, with guard, to a horizontal, open dripproof induction motor complying with NFPA 20-2013. Mount pump and motor on a one-piece drip-rim base of fabricated steel.
- D. Home (Union) Fittings: provide the following trim and fittings conforming to NFPA 20-2013:
 1. Eccentric suction side reducer.
 2. Concentric discharge side increaser.
 3. Automatic air release valve.
 4. Casing relief valve.
 5. Suction and discharge pressure gauges with gauge cocks.
 6. Test header.
 7. 2.5" hose valves.
- E. Fire pump controllers: UL listed combined motor starter and power transfer switch for automatic start-stop operation and solid state reduced current soft starting with variable speed drive. Controller shall conform to NFPA 20-2013 and shall include the following features:
 1. Heavy gauge steel cabinet with dripproof hood.
 2. Front-mounted isolation switch.
 3. Controller withstand rating greater than the maximum fault current value at the point of application as indicated on the Electrical Drawings. Minimum 100,000 amperes.
 4. Magnetic trip type circuit breaker with time delay relay.
 5. Pressure switch with individually adjustable high and low setpoints.
 6. Adjustable running period timer.
 7. Contacts for external circuits to the building fire alarm system for remote alarm of:
 - a. Pump running.
 - b. Loss of line power.
 - c. Phase reversal.
 - d. Transfer switch on emergency.
 - e. Emergency isolation switch open.

8. Digital display, readable with the door closed, to indicate line voltages, line currents, and system pressure.
 9. Manufacturer: Clark, Firetrol, GE, Hubbell, Master, or Metron.
 10. Pressure sensing lines shall be copper or brass with threaded joints.
- F. Jockey pumps: multistage, vertical centrifugal type, with cast iron casing, stainless steel impellers and shaft, mechanical seals, and open dripproof induction motor.
- G. Jockey pump controllers: combined manual and automatic start-stop controller of same manufacturer as the fire pump controller. Provide manual-off-automatic starter, bourdon tube type pressure switch with adjustable high and low setpoints, and fusible disconnect switch with externally operable handle. Install in a wall-mounted dripproof cabinet.
- H. Fire pump flow meters: FM approved flow meter element and gauge operating on the orifice or venturi principle. Test capacity shall be at least twice the rated pump capacity. Gauge shall be designed for permanent wall mounting and shall be a dry-type device responding to the movement of a diaphragm or bellows. The gauge face shall be graduated to read in gpm. Mercury-filled gauges are not acceptable. Tubing connecting the flow element and gauge shall be hard drawn copper.
- I. Fire pump test headers: semi-flush mounted header with 3" outlets, galvanized pipe nipples, 3" x 2.5" straight-way hose valves with caps and chains, and escutcheon plate lettered "Pump Test Connection". Provide a minimum of one valve for each 250 gpm of fire pump rated capacity. Surfaces exposed to view outside the building shall be polished chrome. Hose threads on valves and adaptors shall be National Standard Fire Hose threads.

2.4 FIRE HOSE VALVES AND ACCESSORIES

- A. Hose threads on valves and adaptors shall match the local fire department standard.
- B. Hose valves for wet standpipes for maximum valve inlet service pressure up to and including 175 psig: rough brass angle body type. Working pressure shall be 300 psig.
- C. Pressure settings for pressure reducing hose valves on wet standpipes shall be factory-set as follows:
1. 2.5" hose valves: adjust outlet pressure to 100 psig at 250 gpm.
- D. Provide a 2.5" x 1.5" brass reducer, threaded cap, and chain for each 2.5" hose valve.
- E. Roof manifolds: cast brass body with a 4" inlet and two 2.5" outlets. Provide two 2.5", 300 psig hose valves with rough brass body, caps, and chains. Manifold piping exposed on the roof shall be galvanized. Paint threaded connections with cold galvanized compound.

2.5 FIRE DEPARTMENT CONNECTIONS

- A. Polished chrome-plated brass, 4-way, 2.5" x 4", free-standing, connection with matching caps and chains. Provide a check device in each 2.5" inlet. Hose threads on valves and adaptors shall match the local fire department standard. Provide matching pipe sleeve and round identification plate lettered "Auto Spklr-Standpipe".
- B. Provide an automatic ball drip on each fire department connection.
- C. Access boxes: high density polyethylene, with cover.
1. Manufacturer: Carson L910 or equivalent.

2.6 SPRINKLER HEADS

A. General:

1. Sprinkler heads shall be the product of one manufacturer.
2. Unless indicated otherwise on the Drawings, sprinkler heads shall have a 0.5" orifice and 0.5" threaded connection, and a glass-bulb thermal element.
3. Where noted on the Drawings, sprinklers shall be standard response type. Unless noted otherwise, sprinklers shall be quick response type.

B. Upright sprinklers: rough brass body.

C. Pendent sprinklers: recessed type with white body and white ceiling cup.

D. Pendent sprinklers: concealed type with brass body with white coverplate. Dome cover plates are not acceptable.

E. Pendent sprinklers: recessed, dry type with white body with white ceiling cup.

2.7 DELUGE VALVES

A. Cast iron, bronze-mounted type, with electric release trim. Release solenoid valve shall operate at 24 V DC and shall not trip the system upon loss of power.

B. Provide an air pressure maintenance device and desiccant dryer with transparent bowl and silica gel crystals.

C. Configured for preaction service unless otherwise indicated on the Drawings.

2.8 AIR COMPRESSORS

A. Air compressors: air-cooled, motor-driven single-stage compressor mounted on the system riser. Provide controls for automatic start-stop operation including unloading device, pressure switch, gauge, and relief valve. Normal operating range shall be 0 psig to 65 psig. The compressor shall be sized in accordance with NFPA 13-2013 to restore normal air pressure within 30 min. Operating voltage shall be 120 V, 1-phase.

2.9 ALARM AND SUPERVISORY DEVICES

A. Alarm switches for wet pipe systems: vane type with flexible vane, SPDT contacts, a tamperproof cast aluminum housing with red enamel finish, and a steel U-bolt. The switch shall have an instantly recycling pneumatic retard mechanism field adjustable from 0 s to 60 s.

B. Alarm switches for dry pipe systems: pressure type with adjustable setpoint. Switch shall operate on rising pressure. Provide a water-resistant metal housing with red enamel finish.

C. Valve tamper switches: designed for OS&Y valves or valves with indicator posts as indicated on the Drawings. The switch shall mount without the use of blocks and shall not interfere with valve operation. A signal shall be initiated before the valve stem moves more than 20% of its total travel or if the housing cover is removed.

D. Air pressure supervisory switches: pressure operated type with field-adjustable setpoints. Switches shall supervise both high and low air pressure conditions in the piping system.

E. Manufacturer: Potter Electric, or System Sensor.

2.10 ACCESSORIES

- A. Hangers and supports: UL listed and as specified in Section 210010, Fire Suppression General.
- B. Valve tags and nameplates: as specified in Section 210010, Fire Suppression General.
- C. Pressure gauges: UL listed, bourdon tube type with metal case, 3.5" dials, accuracy within 1% of full scale range, equipped with snubbers and brass needle valves. Maximum gauge limit shall be approximately twice the normal working pressure where the gauge is installed.
- D. Automatic ball drip valves: ball check type, closed when inlet is pressurized, with bronze body and threaded connections.
- E. Test and drain connections: UL listed, FM approved, factory-assembled unit consisting of a control valve, sight glass, 0.5" orifice, and relief valve. The discharge from the relief valve shall be connected to the drain. The device shall be tapped for a pressure gauge. The drain connection shall allow unobstructed flow through the device.
 - 1. Manufacturer: AGF, or Victaulic.
- F. Flexible sprinkler connections: Flexible sprinkler connections may be used at the contractor's option. Flexible connections shall be UL listed, factory-assembled units including a 1" diameter stainless steel hose, braided stainless steel outer jacket, threaded adaptors at each end, a ceiling mounting bracket, and an adjustable sprinkler clamping device. Minimum working pressure shall be 175 psig.
 - 1. Manufacturer: Flexhead Industries or Victaulic.
- G. Air vents: manual type with brass body and threaded outlet.

PART 3 - EXECUTION

3.1 ABOVEGROUND PIPE AND FITTINGS

- A. Run pipe parallel to column centerlines. Pipe shall be installed as high as possible to maintain maximum head room. Provide auxiliary drains to drain the piping system.
- B. Piping arrangements shall be made as compact as possible. Spool pieces and pipe nipples shall be as short as installation will allow.
- C. Use galvanized piping and fittings for compressed air piping, ball drip discharges, drains subject to alternate wetting and drying, and water motor alarm piping.
- D. Fittings and joints shall be assembled using threaded, flanged, or grooved connections. No welded joints or weld formations, either shop- or field-fabricated, shall be used except as specified herein.
- E. Threads cut into galvanized pipe shall be painted with zinc-rich cold galvanizing compound.
- F. Threads on fittings and bolts shall be fully engaged. Threads shall be made up using joint compound or Teflon tape.
- G. Drains and discharges from relief valves, ball drips, and drip rims shall be piped to spill directly over the nearest floor drain. Test connections shall be piped to spill outside the building.
- H. Install an air vent at the high point of each standpipe and sprinkler riser.

- I. Provide an inspector's test connection for each water flow switch in the system.
- J. Torch cutting is not permitted as a means of modifying sprinkler or standpipe systems.
- K. Joints and fittings in copper tubing shall be threaded.

3.2 VALVES

- A. Gate valves shall be installed with the stems pointing above the pipe centerline.

3.3 FIRE PUMPS AND CONTROLLERS

- A. Joints in fuel piping shall be made up with compound specifically designed for hydrocarbon service.
- B. Fire pumps shall start automatically on a drop in water pressure.
- C. Pumps and drivers shall be aligned and mounted on a heavy one-piece steel frame and grouted to a concrete pad.
- D. Controllers shall be arranged for manual stop.
- E. Provide control wiring from the transfer switch to the engine-generator set controls as required for start-stop control of the generator.

3.4 FIRE HOSE VALVES AND ACCESSORIES

- A. Locate hose valves 4'-0" above the floor. Piping drops to hose valves shall be supported within 24" of the valve.
- B. Install a pressure gauge with gauge cock at the top of each standpipe riser.

3.5 FIRE DEPARTMENT CONNECTIONS

- A. Set plumb.

3.6 SPRINKLER HEADS

- A. Install sprinkler guards on sprinklers located lower than 7' above the floor, and on sprinklers located in electrical rooms, communications rooms, and janitor's closets. When installed in elevator equipment rooms or elevator shafts, sprinklers shall have wire guards.
- B. Install near the fire pump controller a painted steel cabinet containing 24 extra sprinkler heads and one sprinkler wrench. Proportion heads as to type and temperature rating.
- C. Refer to Architectural Reflected Ceiling Plans to coordinate sprinkler locations. Sprinkler heads shall be aligned on the ceiling and centered in the ceiling tiles. Head escutcheon plates shall be set tight against the ceiling.
- D. Locate sprinkler heads under exposed ductwork where the obstruction is wider than 48".

3.7 ALARM AND SUPERVISORY DEVICES

- A. The retard mechanism of vane type flow switches shall be adjusted as follows.
 - 1. Sprinkler systems at 30 s.
 - 2. Standpipe master flow switch at 90 s.
- B. Valves shall be monitored in the open position unless indicated normally closed on the Drawings.
- C. Where valves are monitored in the normally closed position, provide a sign attached to the valve to indicate that the valve is normally closed.

3.8 ACCESSORIES

- A. Hangers and Supports:
 - 1. The installation and spacing of hangers for sprinklers shall conform to NFPA 13-2013.
 - 2. The installation and spacing of hangers on standpipe feed mains and risers shall conform to NFPA 14-2013.
 - 3. Sprinkler piping below ductwork shall not be supported directly from the ductwork but by trapeze hangers or angles conforming to NFPA 13-2013.
 - 4. Seismic restraints shall be as specified in Section 210010, Fire Suppression General.
- B. Hydraulic identification nameplates: provide nameplates for each sprinkler system recording data required by NFPA 13-2013.
- C. Test and drain connections: where failure of a pressure reducing valve would subject the sprinkler system to pressures exceeding 175 psig, install a pressure gauge with cock on the inlet of the drain connection and a 0.5" automatic pressure relief valve in a bypass position around the drain connection. Set relief valve to open at 175 psig.

3.9 PAINTING

- A. Interior: fire protection pipe and fittings exposed to view without the removal of ceilings shall be cleaned to remove grease, oil, and scale and then painted 1 coat of metal primer followed by 1 coat of red, high gloss finish. Do not paint copper, brass, or glass surfaces, sprinkler heads, valve stems, or nameplates.

3.10 FLUSHING

- A. Prior to connection of inside piping, new underground pipe shall be flushed in accordance with NFPA 24-2013 until foreign matter is blown out and the stream runs clear.

3.11 TESTS

- A. Prior to covering the joints of underground pipe, the pipe shall be hydrostatically tested for 2 hours at a pressure of 200 psig. Leakage allowance shall be within the limit specified in NFPA 24-2013. The municipal water main and the plumbing system shall be isolated for this test. Submit a Contractor's Material and Test Certificate for Underground Piping in accordance with NFPA 13-2013 and NFPA 24-2013.
- B. Prior to being concealed by walls or ceilings, each portion of the interior piping shall be hydrostatically tested for 2 hours at 200 psig measured at the bottom of the system. Leaks shall be repaired until the system test pressure is maintained for 2 hours. Hydrostatic tests shall be made after drop nipples have been cut back and sprinkler heads have been installed. Submit a Contractor's Material and Test Certificate for Aboveground Piping in accordance with NFPA 13-2013.

- C. In addition to the standard hydrostatic test, an air leakage test shall be performed on double interlocked preaction sprinkler systems. Air leakage test at 40 psig shall be conducted for 24 hours. Any leakage which results in a loss of pressure in excess of 1.5 psig for the 24 hours shall be corrected.
- D. At the completion of the work, conduct a comprehensive inspection of sprinkler systems to ensure that systems are operational. Submit a letter certifying that, as of the date of the inspection, manual sprinkler control valves were open, deluge valves were operational, water flow and tamper switches were operational, sprinkler heads were installed, and the fire pump was in service.
- E. The sprinkler system acceptance tests shall be witnessed by representatives of the Owner, the Contractor, and the local fire department. Provide test equipment and instruments. The acceptance test shall demonstrate operation of initiating detector system, water flow switches, time to trip valve, time to discharge water from test connection, and manual and automatic operating sequences. Submit a typed report, similar to that shown in NFPA 13-2013, recording test results, pressure switch settings, motor current and voltage readings, and witnesses.
- F. Fire pumps shall be field tested in accordance with NFPA 20-2013. Prior to scheduling the formal acceptance test, the pumps shall be run and the entire installation shall be checked to ensure proper operation and to ensure that accessories have been provided. When preliminary tests have been completed, submit a written request for formal acceptance testing. This request shall be accompanied by a letter from the pump manufacturer's representative outlining the results of the preliminary tests. Submit the request at least 7 days prior to the scheduled test date.
- G. The fire pump acceptance tests shall be witnessed by representatives of the Owner, the Contractor, and the local fire department. Factory-trained representatives of the pump supplier and the engine manufacturer shall be present to assist with the test. Provide test equipment and instruments including hose, discharge diffusers, pressure gauges, tachometer, and ammeter. Provide a hose and discharge diffuser for each outlet on the pump test header. A copy of the manufacturer's certified fire pump shop test curve shall be available at the test. The acceptance test shall demonstrate operation on emergency power and operation of remote pump monitor signals. Submit a typed report, similar to that shown in NFPA 20-2013 Appendix A, recording test results, pressure switch settings, motor current and voltage readings, and witnesses.

END OF SECTION 213000

SECTION 213500 – CLEAN AGENT FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other fire suppression systems are specified in other Sections of Division 21.
- B. This Section covers the fire detection and clean agent fire suppression systems for the server room.
- C. Systems shall include mechanical and electrical hardware, piping, wiring, and appurtenances for a complete installation.
- D. Extinguishing systems shall be pre-engineered, total flooding, automatic and manual type.
- E. System pipe sizes indicated on the Drawings are preliminary sizes and shall not relieve the Contractor of the responsibility of sizing the piping in accordance with calculations based on actual equipment to be installed.
- F. Systems shall achieve a uniform 7% concentration by volume within a 10 second discharge period. Minimum space temperature is 70°F. Maximum space temperature is 78°F. Agent quantity shall be based on the volume of the empty space. No allowance shall be taken for the volume of the contents. Agent concentration in the room shall not exceed 8%.
- G. Systems shall employ a central storage method of agent distribution.
- H. This Section includes responsibilities and obligations in support of the performance verification specified in Section 210090, Fire Suppression Performance Verification, and general commissioning requirements.

1.2 QUALITY ASSURANCE

- A. Equipment shall be listed by Underwriters Laboratories (UL).
- B. The installer shall be a factory-authorized engineering and equipment distributor and shall be regularly engaged in clean agent system installation. Include with the submittals a proposal for periodic system inspection and maintenance including certification that the installer has UL listed facilities to recharge the entire system within 48 hours after discharge.

PART 2 - PRODUCTS

2.1 EXTINGUISHING SYSTEMS

- A. System components including storage containers, control heads, nozzles, and detection system control panel shall be furnished by 1 manufacturer. The manufacturer's name and serial number shall appear on major components.
- B. Manufacturer: Viking Fire Products.

2.2 EXTINGUISHING AGENT

- A. The fire extinguishing agent shall be FM 200™ (Heptafluoropropane) stored as a liquified compressed gas and dispensed into the hazard as a colorless vapor.

2.3 CONTROL PANELS

- A. Control equipment shall be enclosed in a surface-mounted, painted steel, NEMA 1 enclosure. The panel shall have dead front construction. Alarm indicators shall be visible when the panel door is closed. Provide a key lock and 2 sets of keys. The control panel shall be listed for release device service. Circuits shall employ Class B (nonredundant) wiring.
- B. System input power shall be 120 V, 60 Hz, single phase. Operating power shall be 24 V DC. The power supply shall include:
 - 1. Solid state rectifier.
 - 2. Power on indicator.
 - 3. Ground fault indicator.
 - 4. Audible trouble indicator with silence switch.
 - 5. Battery test switch.
 - 6. System reset switch.
- C. Provide at least 2 supervised alarm initiating (detector) circuits with alarm and trouble indicators for each circuit. Alarm receipt shall have priority over trouble.
- D. The panel shall supervise the following circuits as a minimum:
 - 1. Detector circuits.
 - 2. Alarm signaling circuits.
 - 3. System firing circuits.
 - 4. Manual release stations.
 - 5. Battery placement connections.
- E. The control panel shall have rechargeable standby batteries with automatic charger. Batteries shall be sealed, maintenance-free type. Upon loss of the main power supply, the systems shall automatically switch to battery power. Batteries shall be capable of powering the system for 24 hours and thereafter to discharge agent and sound alarms for 10 minutes. Batteries shall be housed within the control unit or within a matching cabinet. A trouble alarm shall sound when the system is operating on batteries or when battery voltage drops to 75% of normal terminal voltage.
- F. The panel shall include the following additional features:
 - 1. Discharge time delay field-adjustable from 0 s to 60 s.
 - 2. Auxiliary relays for supplemental functions specified in the operating sequence.
 - 3. A separate "Agent Discharged" visible indicator properly labeled.
 - 4. A "Battery Trouble" visible indicator.
- G. Manufacturer: Notifier NSF-320.

2.4 REMOTE ANNUNCIATORS

- A. Remote annunciators shall be flush-mounted and shall operate on 24 V DC power supplied from the extinguishing system control panel. Wiring connections into the annunciator shall be made using terminal strips.

- B. Cabinets shall be heavy gauge welded steel with welded corners, epoxy enamel painted finish, and a hinged front panel with a key lock. Front panels shall have a clear anodized aluminum surface with a silk screened plan of the hazard area, and a light test button. Underfloor and ceiling smoke detectors shall be located by high brightness LEDs secured to the panel face with clips.

2.5 SMOKE DETECTORS

- A. Smoke detectors used in the system shall be a model recommended by the equipment manufacturer and published on his standard data sheets. Smoke detectors shall be listed in accordance with UL 268-2016. Detectors shall lock in on alarm and shall have an alarm indicating LED. Detectors shall employ a base with a self-locking plug-in design. The base assemblies of photoelectric and ionization-type smoke detectors shall be compatible, allowing free interchange of detector types.
- B. Photoelectric detectors shall operate on the light scattering principle and shall employ solid state circuitry and an LED light source. The detector shall have a built-in time delay cycle or other signal verification feature for additional detector stability.

2.6 AGENT STORAGE CONTAINERS

- A. Extinguishing agent shall be stored in containers as a liquid superpressurized with dry nitrogen to 360 psig at 70°F.
- B. Agent storage containers shall be factory filled, high strength alloy steel.
- C. Containers shall have a baked enamel paint finish and a permanent nameplate showing agent type, gross weight, pressurization level and UL listing mark.
- D. Modular containers shall be wall mounted. Provide a factory-fabricated, painted steel bracket. Each container assembly shall include a fill valve, rupture disc, pressure gauge, and low pressure alarm switch.
- E. Central storage containers shall be floor-mounted and secured by mounting brackets and straps. Each container assembly shall include a discharge valve, valve actuator, overpressure relief device, pressure gauge, and low pressure alarm switch. A means shall be provided at the containers to manually release the extinguishing agent.

2.7 PIPING AND FITTINGS

- A. Piping shall be black steel conforming to ASTM A53/A53M-2018 seamless or electric resistance welded or ASTM A106/A106M-2019a and to ASME B36.10M-2018. Piping shall be schedule 40 in sizes 4" and smaller and schedule 80 in sizes larger than 4".
- B. Pipe joints shall be threaded, cut-grooved, or flanged. Fittings shall be 300 psig malleable iron conforming to ASTM A197/A197M-2000 (2019). Threads shall conform to ASME B1.20.1-2013(R2018).

2.8 HANGERS

- A. Pipe hangers and attachments shall be UL listed. Hangers for piping 4" and smaller shall be adjustable swivel split ring type conforming to MSS SP-58-2018, type 6. Hangers for piping larger than 4" shall be adjustable clevis type conforming to MSS SP-58-2018, type 1. Hangers shall be galvanized steel or galvanized malleable iron.
- B. Beam clamps: MSS SP-58-2018, type 21.

2.9 NOZZLES

- A. System nozzles shall be fabricated of aluminum or chromium-plated brass and shall have drilled orifices of the proper diameters as dictated by the calculations. Provide chromium-plated ceiling escutcheons at nozzles on suspended ceilings. Each nozzle shall be permanently marked to indicate the orifice size and type.
- B. Maximum nozzle flow rate shall be 25 lb per second.

2.10 MANUAL RELEASE STATIONS

- A. The remote manual release shall operate electrically and shall discharge agent immediately upon operation.
- B. The station shall employ a dual-action design requiring 2 distinct motions to operate and shall require a key to reset.
- C. Stations shall be semiflush- mounted and shall be prominently identified as an extinguishing agent release device.

2.11 RELEASE ABORT SWITCHES

- A. The abort switch shall provide a temporary manual means of interrupting the system actuation circuit between alarm and automatic release. The switch shall interrupt the signal from detection to automatic system operation relays. The switch shall not interrupt the wiring from the control panel firing circuit to the valve actuators. Locking or Keyed abort stations are not permitted.

2.12 WIRING AND RACEWAYS

- A. Minimum conductor size shall be #16 AWG.

2.13 PREALARM (FIRST STAGE ALARM) DEVICES

- A. 24 V DC, 6" diameter, vibrating bell with underdome design. Minimum sound output level shall be 90 dB at 10'. Bell dome shall be finished with red enamel.

2.14 PREDISCHARGE ALARM DEVICES

- A. 24 V DC vibrating horn with integral lamp and red lens. Horns shall be semiflush- mounted and finished with red enamel. Minimum sound output level shall be 90 dB at 10'.

2.15 DISCHARGE WARNING SIGNALS

- A. Provide a pressure activated alarm switch in the discharge piping to initiate a "System Discharged" signal on the control panel. This switch shall function upon either an automatic or manual system discharge release.

2.16 ACCESSORIES

- A. Cable ties: Ideal, or Tybar.
- B. Paint: type NCH, high gloss enamel, Rust-Oleum 964 Federal Safety Red.

PART 3 - EXECUTION

3.1 OPERATING SEQUENCE

- A. Automatic system release shall be by cross-zoned smoke detectors.
 - 1. Activation of a single smoke detector circuit shall:
 - a. Light the proper circuit alarm lamp on the control panel.
 - b. Sound prealarm signals and activate the building fire alarm system.
 - c. Close doors and stop air conditioning systems serving the protected area.
 - d. Light the proper detector lamp on the remote annunciator (underfloor detectors only).
 - e. Initiate damper operation to isolate the protected area.
 - 2. Subsequent activation of the second smoke detector circuit shall:
 - a. Start an adjustable discharge time delay.
 - b. Light the proper circuit alarm lamp on the control panel.
 - c. Light the proper detector lamp on the remote annunciator (underfloor detectors only).
 - d. Sound the alarm signals.
 - 3. After expiration of the discharge time delay:
 - a. Discharge extinguishing agent into the hazard.
 - b. Operate the "Agent Discharged" lamp on the control panel.
- B. Operation of a manual release station shall bypass time delays and abort switches and immediately discharge the system. Fire alarm activation, equipment shut-down, and hazard isolation shall occur as specified herein for automatic release.
- C. At any time prior to the expiration of the discharge time delay, it shall be possible to stop the discharge sequence by operation of a manual abort switch.
- D. Operation of the abort switch shall cause audible and visible trouble signals at the control panel. Abort switches shall not prevent system discharge by a manual release station.

3.2 SMOKE DETECTORS

- A. Locate in accordance with NFPA 72-2013.
- B. Spacing shall not exceed 250 ft² on ceilings and 250 ft² below raised floors.
- C. Protect during construction with plastic covers.

3.3 PIPING AND FITTINGS

- A. Piping shall run parallel to building column lines. Piping shall be concealed above suspended ceilings.
- B. Piping shall be reamed and cleaned prior to making up joints.
- C. Joints shall be made up using joint compound or Teflon tape applied to the male threads only.
- D. Pipe hanger rods shall be 0.375" for pipe 1.5" and smaller and 0.5" for pipe larger than 2".

- E. Hanger locations shall conform to ASME B31.1-2018. Design shall be based on actual weight plus 250 lb live load per span. Hanger spacing shall not exceed 7' for pipe 2" and smaller and 12' for piping larger than 2".
- F. Prior to final assembly of the pipe distribution network, pipe and fittings shall be thoroughly cleaned with a degreasing solvent. Metal filings and chips shall be removed.
- G. After assembly of the piping system, discharge nozzle positions shall be bagged and the piping blown out with compressed air.
- H. Discharge pipe which contains more than 1 change in direction between the agent storage container and the distribution nozzle shall be pneumatically tested in a closed circuit for 10 minutes at 150 psig. At the end of 10 minutes, the pressure drop shall not exceed 10% of the test pressure.

3.4 NOZZLES

- A. Where nozzles are installed in lay-in ceilings, ceiling tiles within 4' radius of the nozzle shall be clipped to the ceiling grid.

3.5 SWAY BRACING

- A. Provide sway bracing on piping to limit movement during system discharge. Longitudinal bracing shall be installed 40' on center, and lateral bracing installed 20' on center. Nozzles shall be secured from movement with 4-way braces. Braces shall limit movement to maximum 0.5".

3.6 MANUAL RELEASE STATIONS

- A. Mount manual release and abort stations 4'-6" above finished floor.

3.7 WIRING AND RACEWAYS

- A. Conductors shall be color-coded and tagged at each junction and terminal connection.
- B. Conductors within the control panel and remote annunciator shall be neatly laced with cable ties.
- C. Run power wiring and 24 V DC low voltage wiring in separate raceway.
- D. Conductors shall be installed within galvanized steel EMT. Flexible metallic tubing in lengths not exceeding 2' may be used at individual devices.

3.8 PAINTING

- A. Distribution piping exposed to view without the removal of ceilings shall be painted.
- B. Clean piping thoroughly and apply 1 prime coat and 1 finish coat of enamel paint, color as selected by the Architect.
- C. Piping adjacent to modular storage containers shall be painted to match the color of the container.

3.9 ENCLOSURE INTEGRITY AND FUNCTIONAL TESTS

- A. Prior to enclosure integrity testing, the perimeter of the hazard shall be inspected to discover any unclosed openings which would cause extinguishing agent loss.

- B. The tests shall be witnessed by representatives of the Owner, Architect, and the Contractor, Coordinate the time and date of the test with all parties. At least 10 days notice shall be given.
- C. The enclosure integrity testing shall be conducted as described in NFPA 2001-2015, Appendix B.
- D. Functional tests shall be conducted as required by NFPA 2001-2015. Initiators shall be disconnected from agent containers during this procedure.
- E. Upon acceptance of the test results, the entire system shall be placed in service within 2 hours.
- F. Submit a typed report describing each of the above tests and documenting results.

END OF SECTION 213500

SECTION 220010 – PLUMBING GENERAL

PART 1 - GENERAL

1.1 DESCRIPTION

- A. These plumbing general provisions specified herein apply to all Sections of Division 22.
- B. Refer to the General and Supplementary Conditions and Division 01 for special requirements and conditions which apply to all Sections of Division 22.
- C. This Division and the following Sections include responsibilities and obligations in support of the performance verification specified in Section 220090, Plumbing Performance Verification. and commissioning specified in Section_____.
- D. This Section covers the plumbing general requirements.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. North Carolina State Energy Conservation Code-2018.
 - 2. North Carolina State Plumbing Code-2018.
- B. Codes, standards and regulations specified herein refer to the edition date. Revisions and addenda to these codes, standards and regulations shall be part of these specifications. Provisions of referenced codes, standards, and regulations do not create duty or responsibility by the Engineer or the Owner, unless otherwise specified herein.
- C. Codes, standards and regulations referred to are minimum standards. Where the requirements of these specifications or drawings exceed those of the codes, standards and regulations, the drawings or specifications shall govern.
- D. Plumbing Design Coordination:
 - 1. Reasonable efforts have been made to coordinate plumbing with the following associated trades.
 - 2. Electrical:
 - a. The power ratings of motors, and other plumbing electrical equipment with the electrical characteristics serving them, as specified herein and indicated on the Drawings, have been established as minimums which will allow that equipment to satisfactorily function while producing the required capacities. These power ratings include a safety factor deemed appropriate to accommodate common differences between design parameters and field construction practices. Under no circumstances shall equipment with power ratings less than those indicated on the Drawings or specified herein be provided.
 - b. Differences among manufacturers of plumbing equipment make it impossible to produce a single electrical design which will satisfy the varying electrical requirements of those manufacturers. Consequently, the Contractor shall coordinate the electrical requirements of the plumbing equipment actually furnished on this Project, and provide the electrical systems required by that equipment. This coordination effort shall be completed prior to the installation of either the plumbing equipment or the electrical systems serving that equipment. Electrical system revisions required to coordinate with the plumbing equipment actually furnished shall be provided at no additional cost to the Owner.
 - c. Coordinate the location of the engine-generator set and fuel supply requirements.

3. HVAC:
 - a. Coordinate with the HVAC equipment for final locations of floor drains, and make-up water.
4. Fire Suppression:
 - a. Coordinate with fire pumps for final locations of floor sinks.
- E. Low-Emitting Materials
 1. Adhesives, sealants, sealant primers, paints, and coatings used inside the building (defined as inside the weatherproofing envelope and applied on-site) shall be tested and determined compliant with California Department of Public Health (CDPH) Standard Method v1.2-2017, using the applicable exposure scenario.
 2. Methylene chloride and perchloroethylene shall not be intentionally added in paints, coatings, adhesives, or sealants that are applied on-site.
 3. All paints and coatings that are wet-applied on site and used inside the building must meet the applicable VOC content limits of one of the following:
 - a. California Air Resources Board (CARB) 2019, Suggested Control Measure (SCM) for Architectural Coatings
 4. All adhesives and sealants that are wet-applied on site and used inside the building must meet the applicable VOC content requirements of SCAQMD Rule 1168, July 1, 2017.
 5. All exterior applied adhesives, sealants, coatings, and waterproofing materials must meet VOC content limits of BOTH of the following:
 - a. California Air Resources Board (CARB) 2019 Suggested Control Measure (SCM) for Architectural Coatings
 - b. South Coast Air Quality Management District (SCAQMD), Rule 1168, effective July 1, 2017.
 - 1) Small containers of adhesives and sealants subject to state or federal consumer product VOC regulations are exempt.
 6. Paint that is applied on site shall not contain lead or any intentionally added cadmium.
- F. Install all plumbing systems specified in Division 22, including connections to equipment provided by others, in accordance with the applicable manufacturer's instructions, except where the requirements are more stringent herein, then these specifications shall govern.

1.3 SPACE CONDITIONS

- A. Drawings are diagrammatic in nature and, unless explicitly dimensioned, indicate approximate locations of fixtures, apparatus, equipment and piping. Changes in the location, and offsets, of same which are not shown on the Drawings but are necessary in order to accommodate building conditions and coordination with the work of other trades, shall be made during the preparation of coordination drawings and prior to initial installation, without additional cost to the Owner.
- B. Provide access to equipment and apparatus requiring operation, service or maintenance throughout the life of the system.
- C. Piping or equipment shall not be installed in electrical equipment rooms, elevator equipment rooms, or elevator shafts unless specifically indicated on the Drawings. In addition, piping or plumbing equipment shall not be installed in the space equal to the width and depth of switchgear, switchboards, panelboards, and motor control centers from floor to structure above nor within the working space in front, rear and/or side (where rear and/or side access is required to work on equipment) of electrical equipment (switchgear, switchboards, panelboards, motor control centers, variable frequency drives, transformers, and starters). Dimensions of the working space shall be a minimum depth of 42" horizontally, the width of the equipment

or 30", whichever is greater, and the height of the equipment or 78", whichever is greater. Minimum depth shall be increased to 60" for equipment rated over 600 V.

1.4 ASBESTOS MATERIALS

- A. Materials containing asbestos or any trace of asbestos related materials shall not be used on this Project.

1.5 DEFINITIONS

- A. Exposed piping or conduit is that which can be seen when the base building and tenant fit-up is complete without opening or removing access doors or panels or accessible ceiling components.
 - 1. Other piping or conduit is considered to be concealed.
- B. Exterior piping is exposed to outdoor temperatures.
- C. Rainwater piping conveys water from areas exposed to rainfall.
- D. Secondary rainwater piping conveys emergency water from areas exposed to rainfall.

1.6 RELATED WORK DESCRIBED IN OTHER DIVISIONS

- A. Installation of access panels in wall and ceiling construction.
- B. Cutting, coring, waterproofing, and patching of walls, floors, ceilings, roofs and structure of existing buildings.
- C. Painting, except as specified herein.
- D. Electric power, interlock, and control wiring, except as specified herein.
- E. Installation of starters, contactors, thermal overload switches, and remote push buttons, except as specified herein.
- F. Pipe trenches with grates.
- G. Masonry plenums.
- H. Laundry equipment.
- I. Foundation drainage system.
- J. Outside sheet metal downspouts.
- K. Catch basin construction.
- L. Concrete pump pits.
- M. Manhole construction.
- N. Engine-generator sets.

1.7 UTILITY CONNECTIONS AND SERVICE

A. Water:

1. Arrange for connection to the water main, extension of service and installation of a meter of not less than 4" size, with a pressure drop of not more than 3 psi at 180 gpm flow. Pay charges in connection therewith.

B. Sewers:

1. Arrange for the sewer connection and pay charges in connection therewith.
2. The installation shall comply with the requirements of the Water Pollution Control Division of the City.

1.8 SUBMITTALS

- A. Within 15 days after notice to proceed, submit a schedule indicating the proposed submission date of each submittal specified herein. Schedule shall anticipate the submittal review time, the possible need for resubmittals, and the time required for fabrication, shipping and integration into the construction sequence. Engineer will advise of any conflicts in reviewing submittals that the proposed schedule presents.

- B. Submittals shall be prepared in a line-by-line format corresponding to these Specifications and shall indicate compliance with each requirement specified herein and indicated on the Drawings.

1. In addition to any other transmittals or cover sheets used, fill out and attach to each individual submittal a copy of the Cover Sheet for Submittals to Newcomb & Boyd included at the end of this Section.
2. Indicate manufacturer's installation instructions.
3. Indicate deviations, if any, including any from the manufacturer's installation instructions.
4. Reproductions or electronic versions of design drawings shall not be used in the preparation of shop drawings.
5. Resubmittals that are required to address review comments shall include a cover transmittal with a written explanation of how each review comment has been addressed.
6. Submittals not specifically required, or not complying with the format requirements, will be returned unreviewed.
7. Shop drawings and submittals shall be provided in portable document format (PDF). PDF files containing multiple drawings or components shall include an index of the file contents and electronic bookmarks.

- C. Shop drawings shall include the following:

1. Trade shop drawings (i.e., plumbing piping system drawings, electrical main feeder raceway drawings, and mechanical ductwork drawings) shall be submitted within 30 days after award of contract.
2. Approved trade shop drawings shall be utilized as the basis for the coordination drawings. Coordination drawings shall be submitted within 30 days after approval of trade shop drawings.
3. Coordination drawings shall utilize either manual or electronic means of analyzing the work of each trade in spatial relationship with other trades. Locations of conflicts between trades, and the proposed resolution for each conflict, shall be noted on the coordination drawings submitted.
4. No work shall be fabricated and/or installed prior to receipt by the Contractor of approved trade shop drawings and approved coordination drawings without specific written authorization from the Engineer. No change orders will be approved or design assistance provided for remedial field coordination activities for work fabricated and/or installed prior to receipt by the Contractor of approved trade shop drawings and approved coordination drawings.

D. General submittals shall include the following:

1. Performance Verification Supervisor qualifications.
2. Coordination drawings, with dimensions and elevations, of plumbing work including equipment, piping with fittings, valves, accessories and sleeves where applicable, coordinated with the work of other trades, including HVAC, fire suppression, electrical, structural, and architectural, minimum 1/4" = 1'-0" scale.
3. Inertia bases.
4. Seismic restraint devices, including calculations, restraint selection, installation details and written confirmation that a licensed engineer prepared the calculations.
5. Vibration isolation, including spring data, manufacturer's equipment operating weight, actual load distribution and actual deflection at each loading point for each piece of isolated equipment. Shop drawings for piping isolators shall be made on prints of the piping shop drawings.

E. Plumbing submittals shall include the following:

1. Backflow preventers.
2. Domestic water piping and fittings.
3. Drains and cleanouts.
4. Exterior adhesives, sealants, and coatings that are applied on site.
5. Fuel systems equipment, accessories, controls, and alarms.
6. Gauges and thermometers.
7. Hot water circulating pumps.
8. Insulation.
9. Paints, coatings, adhesives, and sealants that are applied on site and inside the building.
10. Petroleum piping and fittings.
11. Piping system drawings, showing equipment, piping, fittings, elevations, dimensions, valves, sleeves, and accessories, coordinated with building conditions and other trades, minimum 1/4" = 1'-0" scale.
12. Plumbing fixtures and trim.
13. Sanitary and rainwater piping and fittings.
14. Sump pumps.
15. Temperature maintenance cable.
16. Valves.
17. Wall hydrants and hose bibs.
18. Water heaters and thermal expansion tanks.
19. Water pressure booster pumps.

1.9 EQUIPMENT AND INSTALLATION REQUIREMENTS

- A. Equipment and materials shall, unless otherwise specified herein, be new and shall be of the customary standard and quality furnished by the designated manufacturer for that catalogue number.
- B. Materials and equipment shall be UL listed, and shall bear the UL listing mark on products for which standards have been established and for which listing is regularly furnished by UL.
 1. In lieu of the UL listing, or where standards have not been established by UL and UL listing is not regularly furnished, materials and equipment shall be listed by a laboratory recognized under the OSHA Nationally Recognized Testing Laboratory Program or by a laboratory accredited by International Accreditation Service. Examples include:
 - a. Canadian Standard Association.
 - b. ETL Testing Laboratories, Inc.
 - c. MET Electrical Testing Company, Inc.

PART 2 - PRODUCTS

2.1 HANGERS AND SUPPORTS

A. General:

1. Make hanger assemblies and channel strut systems complete with hanger rods, nuts, bolts, screw attachments, and upper supports attached to the structure as applicable to Project requirements.
2. Select hanger assemblies for single piping, using the weight of piping, insulation, and valves being supported.
3. Select channel strut systems for gang piping, using the combined weight of the piping, insulation, and valves being supported.
4. Select supports for equipment with an additional live load of 300 lb for workers and supplies.

B. Pipe Hangers:

1. Insulated water piping 0.5" to 3": adjustable band hanger, steel with galvanized finish and threaded swivel knurl nut.
 - a. Manufacturer: Anvil 69, B-Line B3170NF, or PHD 141.
2. Copper tubing 0.5" to 3", non-insulated: adjustable band hanger, steel with copper finish and threaded swivel knurl nut.
 - a. Manufacturer: Anvil CT-69, B-Line B3170 CT, or PHD 152.
3. Steel piping and insulated water piping 4" and larger: adjustable clevis hanger, steel with galvanized finish.
 - a. Manufacturer: Anvil 260, B-Line B3100, or PHD 451.
4. Copper tubing 4" in size: non-insulated: adjustable clevis hanger, steel with copper finish.
 - a. Manufacturer: Anvil CT-65, B-Line B3104CT, or PHD 442.
5. Cast iron piping (insulated and non-insulated): AWWA adjustable clevis hanger, steel with galvanized finish.
 - a. Manufacturer: Anvil 590, B-Line B3102, or PHD 420.
6. Channel strut systems for gang piping: minimum 14 gauge galvanized steel strut with factory-punched attachment holes, and galvanized straps, nuts, bolts, washers, and accessories. Straps shall be designed so that the attachment nut is captive on the shoulder of the strap when tightened, and designed to provide a surface on the turned down edge against the pipe while making positive contact with the side walls of the channel.
 - a. Manufacturer: Anvil, B-Line, PHD, or Unistrut.

C. Equipment Supports:

1. Channel strut systems for equipment supports: minimum 14 gauge galvanized steel strut with factory-punched attachment holes for hanger rods, with stainless steel nuts, and washers.
 - a. Manufacturer: Anvil, B-Line, PHD, or Unistrut.

D. Hanger Rods:

1. One-piece steel type, threaded as required.
2. Sizes for single hangers:

<u>Pipe Size</u>	<u>Rod Diameter</u>
2" and smaller	0.375"

2.5" and 3"	0.5"
4" and 5"	0.625"
6" and 8"	0.75"
10" and 12"	0.875"
14" to 18"	1.0"

E. Embedded Concrete Inserts:

1. Multiple hanger type for piping up to 2000 lb/ft: steel with galvanized finish, channel nuts, end caps, anchor tabs, and nut cavity protection.
 - a. Manufacturer: Anvil PS-5000, or B-Line B221.

F. Expansion Anchor Type, Concrete/Masonry Inserts:

1. Steel sleeve type: for bolting frames to concrete slabs and walls. Complete with threaded stud body, expansion sleeve, hex nut, washer, and stainless steel construction. Anchors shall have a minimum 1000 psig pull out strength.
 - a. Manufacturer: Hilti, ITW, or Powers.
2. Steel overhead sleeve type: to concrete slabs for threaded hanger rods. Complete with threaded stud body, expansion sleeve, female threaded rod coupling nut, washer, and stainless steel construction. Anchors shall have a minimum of 1000 psig pull out strength.
 - a. Manufacturer: Hilti, ITW, or Powers.
3. Steel sleeve type for bolting to concrete block and brick walls: complete with split expansion sleeve over a threaded stud bolt body with integral expander, nut, washer, and stainless steel construction. Anchors shall have a minimum 300 psig pull out strength.
 - a. Manufacturer: Hilti, ITW, or Powers.

G. Steel Beam and Joist Clamps:

1. Wide mouth flange clamp with galvanized finish, cup point set screw with lock nut, and retaining strap.
 - a. Manufacturer: Anvil 93, B-Line 3033, or PHD 360.
2. Center of beam clamp, steel with galvanized finish, screw and tightening nut, and adjustable for 4" to 12" flange widths.
 - a. Manufacturer: Anvil 133/134, B-Line 3055, or PHD 625.

H. Split Ring Clamps:

1. Copper piping 0.5" to 2": hinged split ring pipe clamp, malleable iron with copper finish, threaded rod, and base plate with mounting holes.
 - a. Manufacturer: Anvil CT138R, B-Line B3198HCT, or PHD 512H.

I. Pipe Stand Supports:

1. Piping 4" and larger: steel floor stanchion type with galvanized finish, adjustable pipe saddles with U-bolt yoke, locknut nipple, threaded riser, and threaded baseplate with mounting holes.
 - a. Manufacturer: Anvil 265, B-Line B3092, or PHD 876.

J. Offset Pipe Clamps:

1. Piping 0.75" to 12": steel offset pipe clamp with galvanized finish, top and bottom rings with nuts and bolts.

- a. Manufacturer: Anvil 103, B-Line B3148, or PHD 535.
- K. Riser Clamps:
 - 1. Cast iron piping: AWWA type, steel with galvanized finish, nuts, and bolts.
 - a. Manufacturer: Anvil 261, B-Line B3373DI, or PHD 522.
 - 2. Copper tubing to 6" in size: steel with copper finish, nuts, and bolts.
 - a. Manufacturer: Anvil CT-121, B-Line B3373CT, or PHD 552.
- L. Roof Pipe Supports:
 - 1. For flat roofs: manufactured free standing pipe supports of UV protected plastic or rubber bases, designed to disperse the piping load and protect the roofing membrane from damage. Metal components shall be stainless or galvanized steel. Provide rods, strut channels, clamps, and bolts as required for the assembly to be complete. Provide roof securing brackets.
 - 2. The completed assembly shall be capable of supporting a minimum load bearing of 200 lb, and a minimum 200°F ambient temperature.
 - 3. Install the piping at a nominal 6" above the roof for 1pipes.
 - 4. Manufacturer: Anvil, Cooper B-Line, or Roof Top Blox.
- M. Accessories:
 - 1. Insulation protectors: minimum 18 ga galvanized rolled steel with radius to fit the outside diameter (OD) of the insulation. Provide protectors 12" long for 6" and smaller ODs, 18" long for 8" to 10" ODs, and 24" long for 12" and larger ODs.
 - a. Manufacturer: Anvil 167, B-Line B3151, or PHD 170.

2.2 VALVE TAGS

- A. Minimum 19 gauge polished brass, 1.5" minimum size. Tags shall be round. Stamped numbers and letters shall be not less than 0.75" high, and filled with black paint.

2.3 IDENTIFICATION MATERIALS

- A. Pipe identification shall be 5 mil thick self-adhering laminated vinyl label, meeting ASME A13.1-2015. Lengths may vary due to wording. Widths and legends shall be as follows:

<u>Diameter (Including Insulation)</u>	<u>Width</u>	<u>Size of Legend Letters</u>
0.75 - 1.25"	8"	0.5"
1.5 - 2"	8"	0.75"
2.5 - 6"	12"	1.25"
8 - 10"	24"	2.5"
Over 10"	32"	3.5"

- 1. Legends shall be in full words, easy to read and understand, and in contrasting color to background color.
- 2. Roll tape flow arrows: 5 mil thick self-adhering laminated vinyl tape, meeting ASME A13.1-2015. The tape's background shall match the pipe identification label's background, and flow arrow shall match the legend lettering.
- B. Nameplates and signs: rigid laminated plastic, engraved with white letters. Background color shall be:

<u>System</u>	<u>Color</u>
Equipment served by emergency power	Red
Other equipment	Black

2.4 SLEEVES

- A. Sleeves shall be standard weight steel pipe except sleeves for concealed piping through floors not in structural members, and through interior drywall construction may be formed from 26 gauge galvanized sheet metal lapped and pop riveted.
- B. Sleeves in rated floor slabs shall be cast-in-place, factory-assembled one-piece watertight type.
- C. Sleeves through roof slabs for ventpiping shall be screw type: Josam 26420, Smith 1760, or Zurn Z-197.

2.5 PENETRATION SEALS

- A. Firestops:
 1. Refer to Section Joint Firestopping, 078443.
- B. Expansion Seals:
 1. Waterproof, modular, mechanical expansion type consisting of synthetic rubber grommets or interlocking links shaped to continuously fill the annular space between the penetrating item and the opening. Sizing of links and sleeve shall be determined by the manufacturer.
 2. Manufacturer: Calpico Pipe Linx, Metraflex MetraSeal, or Thunderline Link Seal.

2.6 MOTORS AND STARTERS

- A. Motors:
 1. Motors shall be as specified within the various sections of Division 22, and as may be indicated on the Drawings, and as a minimum include:
 - a. Compliance with NEMA MG 1-2016 (R2018).
 - b. Have a temperature rise as designed by the manufacturer for the motor type, and installation.
 - c. Motors 1 hp and larger shall be NEMA premium efficiency type, in accordance with NEMA MG 1-2016 (R2018)
 2. Refer to Electrical Drawings for motor's electrical characteristics.
 3. Motors and pumps shall be statically and dynamically balanced and shall have steady state radial vibration levels which do not exceed the following:

<u>Equipment</u>	<u>Peak-to-Peak Displacement (mils)</u>
Motors	
under 600 rpm	4
600 to 1000 rpm	3
1000 to 2000 rpm	2
over 2000 rpm	1
Pumps and motors	
over 1800 rpm	1
under 1800 rpm	2

B. Starters:

1. Motor starters shall be as supplied by the pump or compressor manufacturer as specified within the various sections of Division 22, and as a minimum include:
 - a. Manufactured in accordance with NEMA ICS 2-2000 (R2005).
2. 3-phase motors, unless otherwise specified herein as a minimum provide:
 - a. Combination magnetic type with thermal magnetic circuit breaker.
 - b. Circuit breakers having minimum AIC rating as specified in Division 26.
 - c. Automatic test switch on starter.
3. 1-phase motors, unless otherwise specified herein as a minimum provide:
 - a. Manual starting switch with thermal overload protection.

2.7 VIBRATION ISOLATION

A. General:

1. Apparatus shall be by one manufacturer, except where herein specified otherwise.

B. Base Isolators:

1. Inertia bases shall be of welded steel construction with concrete in-fill and shall incorporate isolator mounting brackets, prelocated equipment anchor bolts and pipe sleeves where applicable, No. 4 reinforcing bars, welded 6" on center each way.
2. The weight of each inertia base shall be at minimum sufficient to lower the center of gravity to or below the isolator support plane.
3. Inertia bases shall be a minimum of 6" thick.
4. Height-saving brackets or welded steel pockets shall be incorporated to provide a 2" minimum clearance under each inertia base.

C. Floor Mounted Isolators:

1. Type NP - Neoprene Pad Type: minimum 0.25" thick ribbed or waffled on both sides. Isolator pads shall be selected for less than 80% maximum rated load.
 - a. Manufacturer: Kinetics Noise Control NP, Mason W, Vibration Eliminator 200N, VMC Group Shear-Flex, or Vibro-Acoustics N.
2. Type NS - Sandwich pad type, with minimum 0.25" thick ribbed or waffled neoprene pad bonded to each side of 16 gauge plate. Isolator pads shall be selected for less than 80% maximum rated load.
 - a. Manufacturer: Kinetics Noise Control NG, Mason WSW, Vibration Eliminator P, or VMC Group Multi-Layer Shear Flex, Vibro-Acoustics 400 NP.
3. Type DN - Double-deflection Neoprene Type: with neoprene-coated metal surfaces, and top and bottom surfaces ribbed. Isolators shall have bolt holes in the base.
 - a. Manufacturer: Kinetics Noise Control RD, Mason ND, Vibration Eliminator T44 or D44, VMC Group M, or Vibro-Acoustics RD.
4. Type FS - Free-standing Spring Type: laterally stable, unhoused spring type with leveling bolts for bolting to the equipment. Spring diameter shall be not less than 0.8 of the compressed height of the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Springs shall be complete with neoprene or fiberglass noise isolation pads, minimum 0.25" thick, bonded to the baseplate.
 - a. Manufacturer: Kinetics Noise Control FDS, Mason SLF, Vibration Eliminator OST, VMC Group AW/AWH, or Vibro-Acoustics FS.

D. Hanger Mounted Isolators:

1. Type SH - Spring Hanger Type: combination type hanger with steel spring and double-deflection neoprene or natural rubber element in series. The neoprene or natural rubber element shall have a minimum static deflection of 0.35". Spring diameter shall be not less than 0.8 of the compressed height of the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Hangers shall be designed for a minimum of 15° angular misalignment from vertical before rod contacts housing.
 - a. Manufacturer: Kinetics Noise Control SRH, Mason 30N, Vibration Eliminator SNRC, VMC Group HRSA, or Vibro-Acoustics SHR.
2. Type PSH - Pre-compressed Spring Hanger Type: with a deflection scale and compressed to two-thirds of the load's rated deflection. Hangers shall have a release mechanism to free the spring after installation is complete.
 - a. Manufacturer: Kinetics Noise Control SFH, Mason PC 30N, Vibration Eliminator PCSR, VMC Group HSRA-PR, or Vibro-Acoustics PSHR.
3. Type NH - Neoprene Hanger Type: double-deflection neoprene or natural rubber hanger type, with neoprene or natural rubber grommet between hanger rod and housing. Neoprene or natural rubber element shall have neoprene- or natural rubber-coated metal surfaces.
 - a. Manufacturer: Kinetics Noise Control RH, Mason HD, Vibration Eliminator C, VMC Group HR, or Vibro-Acoustics NH.

E. Piping In-line Isolators:

1. Flexible metal hose connector type: bronze inner corrugated hose and outer woven braid sheath, and solder ends for domestic water piping 3" and smaller to domestic water booster pumps. Connectors shall meet FDA and NSF requirements for lead free, rated for 150 300 psig at 70°F and have a flexible length to provide a minimum of 0.25" offset.
 - a. Manufacturer: Flexicraft, Metraflex, or Proco.
 - b. Solder and flux shall meet California AB1953 standard, which specifies that solder not contain more than 0.2% lead, and flux not more than a weighted average of 0.25% lead for wetted surfaces.

2.8 SEISMIC RESTRAINTS

A. Seismic force design shall be determined in accordance with the following seismic design criteria:

1. Seismic Design Category: D. Occupancy Category: IV.
2. Risk Category: IV.
3. Component Importance Factor, I_p : 1.5.

B. Provide restraint devices as required for vibration isolated and non-vibration isolated plumbing components. Provide calculations to determine restraint loadings for specific components to be installed resulting from seismic forces on components. Seismic restraint calculations shall be signed by a licensed engineer in the employ of the seismic restraint device manufacturer.

C. Exceptions for plumbing components listed within the applicable project building code may be utilized. However, use of exceptions shall be noted with submitted seismic restraint calculations.

D. Seismic restraints and vibration isolators provided with integral seismic restraint capacity shall have Anchorage Preapproval "R" Number from OSHPD in the State of California listing minimum certified horizontal and vertical load ratings.

E. Floor-Mounted Restraints:

1. All-directional external seismic restraints for floor-mounted components shall consist of interlocking steel assemblies restrained when engaged under seismic motion by elastomeric material with a minimum thickness of 0.25". The minimum air gap between interlocking assemblies shall be 0.125".
2. Restraints for neoprene vibration isolators shall consist of Type DN isolators with the addition of welded steel housings to resist seismic forces.
3. Restraints for free-standing floor springs shall consist of Type FS isolators with the addition of welded steel housings to resist seismic forces. Restraints shall allow a maximum movement of 0.25" in all directions.
4. Manufacturer: Kinetics Noise Control, Mason Industries, VMC Group, Vibration Eliminator, or Vibro-Acoustics.

F. Suspended Restraints:

1. Restraints for vibration isolated suspended equipment and components shall consist of galvanized or stainless steel aircraft cables with end connection fittings designed to swivel in order to ensure proper cable alignment and avoid bending of cable.
2. Restraints for nonvibration isolated suspended equipment and components shall consist of steel angle or unistrut with anchor bolts and end connection fittings designed to swivel to the final installation angle.
3. Manufacturer: B-Line, International Seismic Application Technology, Kinetics Noise Control, Mason Industries, Tolco, VMC Group, Vibration Eliminator, or Vibro-Acoustics.

2.9 CONCRETE

- A. Normal weight concrete (145 pcf) using Type I Portland Cement, 1" maximum size coarse aggregate to provide a minimum 28 day compressive strength of 3000 psi.

2.10 GROUT

- A. Nonshrink type, conforming to ASTM C1107/C1107M-2017 when tested at fluid consistency. Grout shall exhibit zero bleeding at every age when mixed to fluid consistency. Minimum 28 day compressive strength, when mixed to fluid consistency, shall be 7000 psi.
- B. Manufacturer: Cormix, or Master Builders.

2.11 ACCESS PANELS - BUILDING

- A. Access panels shall be flush type with concealed hinges. Frame shall be 16 gauge steel or extruded aluminum, and panel shall be 14 gauge steel. Provide flush screwdriver operated cam latches. Panels shall be finished for painting.
- B. Minimum size of panels shall be 12" x 12" for handholes, 18" x 18" elsewhere.
- C. Fire rated access panels shall be UL listed, and shall have 16 gauge steel frames, 20 gauge hollow steel door with fire-resistive insulation, finished for painting, automatic closure springs, and key operated cylinder locks.
- D. Panels in nonaccessible acoustical tile ceilings shall be designed to accept tiles.
- E. Manufacturer: Bar-Co, Cesco, J.L. Industries, Karp, Larsen's, Milcor, or Nystrom.

2.12 ESCUTCHEONS

- A. Split hinged type, constructed of chromium-plated steel or cast brass, sized to fit over insulation and to cover sleeve.

2.13 UNDERGROUND WARNING TAPE

- A. Tape shall be acid- and alkali-resistant polyethylene film tape, 6" wide with minimum thickness of 0.004", specifically designed for marking and locating of underground utilities.
- B. Tape shall be manufactured with integral wires, foil backing or other means to enable detection by a metal detector when the tape is buried up to 3' deep. The metallic core of the tape shall be encased in a protective jacket or provided with other means of corrosion protection.
- C. Tape color shall be as specified below and shall bear a continuous printed inscription describing the specific utility:

<u>Utility</u>	<u>Color</u>
Diesel fuel	Yellow
Domestic cold water	Blue
Domestic hot water	Yellow
Domestic hot water circulating	Yellow
Rainwater	Green
Soil	Green
Waste	Green
Utility located underground, but not listed above	Blue

- D. Manufacturer: Brady, Boddingtons, Carlton Industries, Seton, or Thor Enterprises.

PART 3 - EXECUTION

3.1 PROTECTION OF EQUIPMENT AND MATERIALS DURING CONSTRUCTION

- A. Equipment and Materials-Storage:
1. Provide protective covers, skids, plugs or caps to protect equipment and materials from damage or deterioration during construction.
 2. Store equipment and material under cover, and off the ground or floors exposed to rain.
 3. For outdoor storage, protective covers of 10 mil thick black sheet plastic shall be fitted over equipment and materials. Covers shall be reinforced to withstand wind and precipitation. Set equipment and material on skids or platforms of height to avoid damage or deterioration from spattering and ground water.
 4. Plastic piping shall not be stored in direct sunlight or at temperatures higher than 95°F: Install the protective covering with 12" clearance over the piping top and sides, and provide for air circulation. Store the piping on skids that will protect from heat sagging or bending.
- B. Equipment and Materials-Construction:
1. Plug ends of pipes when work is stopped to prevent debris from entering the pipes.
 2. Provide dust and debris protection for equipment, motors, and bearings operated during construction up to date of substantial completion.
 3. Provide protective covers on floor drains and floor sinks during construction to prevent debris from entering the waste piping system. Do not use any covering that will deface the drain grate's finish.

3.2 EQUIPMENT INSTALLATION REQUIREMENTS

- A. Equipment shall be installed and connected as specified herein or indicated on the Drawings in accordance with the manufacturers' instructions and recommendations for this Project. Furnish and install auxiliary piping, water seals, valves, and electrical connections recommended by the manufacturer for operation.
- B. Refer to manufacturer's or equipment supplier's shop drawings for exact type, number, location, dimensions and size of connections to equipment, and provide rough-ins and connections accordingly, including, but not limited to:
 - 1. Laundry equipment.
 - 2. Vertical transportation equipment.
- C. Final connections to laundry equipment shall be made by the laundry vendor.
- D. For equipment that does not have water cross connection within, provide check valves in the cold and hot water supplies.
- E. In unfinished areas designated for future build-out, install piping, conduit and equipment tight against the structure to maximize future ceiling height.
- F. Motor quantities, sizes and equipment wattage ratings specified herein or indicated on the Drawings are the minimum requirements, unless noted otherwise. Motor quantities, sizes and equipment wattage ratings less than those specified herein or indicated on the Drawings are not acceptable. Larger motor sizes and equipment wattage ratings may only be provided if necessary, to meet the prescriptive requirements specified herein or indicated on the Drawings. Where multiple motors or motor sizes or equipment wattage ratings larger than specified herein or indicated on the Drawings are furnished, provide and coordinate the corresponding increased number or capacity of feeders and other electrical equipment serving them, at no additional cost to the Owner.
- G. Field-installed equipment controls or sensor wiring shall be installed in conduit. Low voltage control and sensor wiring shall be installed in conduits separate from line voltage control wiring and power wiring.
- H. Where water pipe sizes at equipment vary from the pipe size indicated on the Drawings, provide appropriate reducers/increasers directly adjacent to the pipe-equipment unions.
- I. Unless otherwise specified herein or indicated on the Drawings, the size of the valves, piping, and accessories dedicated to a piece of equipment shall not be less than the pipe size to which they are connected.

3.3 HANGERS AND SUPPORTS

- A. General:
 - 1. Piping support spacing shall be from center to center of the support.
 - 2. Support connected piping and equipment independently of each other.
 - 3. Adjust hangers, clamps, and supports so that loading and support is uniform.
 - 4. Suspend hanger rods only from the structure; do not suspend from piping, equipment, or ductwork.
 - 5. Isolate bare copper tubing from ferrous metal hangers, channel strut supports, and building components with felt or rubber liners.
- B. Hangers and Supports:
 - 1. Support 2.5" and smaller piping independently in a parallel plane, and equally spaced side to side, except where a channel strut is used.
 - 2. Support 3" and larger piping independently in a parallel plane, and equally spaced side to side.

3. Provide supports for piping 3" and larger, within 1' of each elbow and tee, and at each valve and strainer.
 4. At groups of close-coupled valves and strainers installed in the same line, provide multiple hangers to eliminate any stress on the piping and valve joints.
 5. Support domestic hot and cold water piping in chases and walls behind plumbing fixtures with brackets and U-bolts secured to the cast iron, fixture carriers, or wall studs as applicable. Select U-bolts to bear on the piping.
 6. Install restraints on drainage piping 5" and larger, at changes in direction, and changes in pipe diameters greater than two pipe sizes, as required by the International Plumbing Code-2018.
- C. Channel Struts:
1. Where multiple pipes 0.5" to 2.5" run parallel and in the same plane, a channel strut system may be used.
 2. The strut spacing shall support the smaller diameter pipe.
- D. Insulated Piping:
1. For insulated piping, provide insulation protectors at each hanger and/or channel strut.
 2. For insulated piping, except cast iron, select hangers and channel strut clamp sizes, for the insulation's outside diameter. Select hangers and clamps to not compress the insulation.
 3. Insulated piping shall run continuous, without any breaks at hangers or channel struts, except cast iron, which shall rest directly on the hanger or channel strut.
 4. Select hangers for insulated cast iron pipe to bear on the pipe. Wrap the insulation around the hanger bottom and fill and seal any voids within the hanger's upper part.
- E. Horizontal Support Spacing:
1. Supports for copper tubing: 0.5" to 1.25" maximum of 5', 1.5" to 2.5" maximum of 8', and 3" and larger maximum of 10'.
 2. Supports for cast iron: excluding fittings, maximum of 5'.
- F. Vertical Support Spacing:
1. Anchor vertical water piping 6' and longer in chases or walls, to plumbing fixtures or equipment, at the pipe's midpoint with split ring clamps attached to the studs.
 2. Anchor vertical piping 8' to 16' in length, located within one space at the pipe's midpoint with offset pipe clamps or split ring clamps, as applicable, attached to the building.
 3. Anchor vertical piping over 16' in length, located within one space at 8' intervals, with offset pipe clamps or split ring clamps, as applicable, attached to the building.
 4. Support soil, waste, vent, and rainwater stacks with riser clamps at each floor.
 5. Support soil, waste, vent, and rainwater piping vertical to horizontal offsets above grade, with a hanger on the first elbow of the offset.
 6. Support water risers with riser clamps at each floor.
 7. Support vertical piping in open shafts on channel struts at every floor line, and as specified above.
- G. Embedded Concrete Inserts:
1. Use for piping and equipment supports in new concrete construction.
 2. Single hanger type: where the weight to be supported exceeds 50% of the inserts rated load capacity, install 2 No. 3 reinforcing rods 30" long, attached to the extended anchors at each end of the insert.
 3. Multiple hanger type: where the weight to be supported exceeds 50% of the inserts rated load capacity, install No. 3 reinforcing rods 30" long, attached to the extended anchors at each end of the insert, and on 12" centers.
- H. Expansion Anchor Type Concrete and Masonry Inserts:
1. Use for piping in cured concrete construction.

2. Install per manufacturer's requirements.
3. Select for maximum load plus a safety factor of 3 times the calculated load.

3.4 SLEEVES

- A. Provide sleeves where pipes pass through walls, floors and roofs, except in the following circumstances:
 1. Cast iron pipe built into masonry walls.
 2. Concealed wall openings of the required diameter in non fire- or smoke-rated construction.
 3. Concealed floor openings formed by the use of plastic forming devices providing a circular opening of the required diameter.
 4. Core drilled concealed openings. Openings in roofs shall not be core drilled. Obtain written permission prior to core drilling.
 5. Pipes passing through concrete floor slabs on grade.
- B. Sleeves shall be placed into position prior to wall, floor, or roof construction. Sleeves shall be tight-fitting and cut smooth.
- C. Floor sleeves shall be cast in place, watertight, and extend from the bottom of the slab to 2" above the finished floor.
- D. Wall sleeves shall extend 1" on each side of walls.
- E. Make sleeves through outside walls above and below grade watertight, and provide stainless steel escutcheons inside and outside.
- F. Size sleeves to have a minimum of 1" annular space to the outside diameter of pipe and/or the pipe insulation, except as follows:
 1. Sleeves in nonrated construction shall be sized to provide clearance all around pipe, including insulation, to accommodate thermal movement. Clearance shall be minimum 0.75".
- G. Furnish 4 psf lead flashing for sleeves through flat built-up roofs extending at least 8" from the sleeve in all directions.
- H. For piping designed for future upward extension, provide steel pipe sleeves in the roof slab accurately aligned for future extension of these lines. Fill these sleeves with a removable insulating material and coordinate sealing of sleeve tops with the roofing system.

3.5 IDENTIFICATION OF PIPING

- A. Label piping specified under this Division in accordance with ASME A13.1-2015.
- B. Labels shall be on the lower quarters of horizontal piping, except where such location would be obscured and at the plane of observation on vertical piping.
- C. Wrap arrow tape completely around the pipe at each end of the label, with arrows pointing in direction of flow.
- D. Locate pipe labels as follows:
 1. Within mechanical rooms and above suspended ceilings:
 - a. Within 18" of each valve or valve assembly.
 - b. Within 36" of tees at both main and branch.
 - c. Within 36" of each 90° elbow.

- d. Not over 20' intervals along horizontal piping.
- e. At midpoint on vertical risers where visible.
- f. Within 18" on each side of a wall.
- g. Within 36" of connections to equipment or vessels.
- 2. Piping concealed in chases or shafts:
 - a. Each pipe visible through an access door or panel on each level.
- 3. Piping exposed in finished rooms:
 - a. Omit identification of piping 0.5" and smaller exposed at connections to equipment or plumbing fixtures.
 - b. With the above exception, identify not less than 1 point on each piping run visible in each room with identification on not over 20' intervals.
- E. Piping with temperature maintenance cable shall be additionally labeled, "Electronically Traced" on the outside of the insulation jacket.
- F. Schedule of Piping Identification:

<u>Piping System</u>	<u>Color Coding Background/Lettering</u>	<u>Legend</u>
<u>Drainage Systems</u>		
Sanitary	Green/White	Sanitary
Waste	Green/White	Waste
Vent	Green/White	Vent
Rainwater	Green/White	Rainwater
Secondary Rainwater	Green/White	Secondary Rainwater
Pumped Discharge	Green/White	Pumped Discharge
<u>Water Systems</u>		
Cold Water	Green/White	Domestic Cold Water
Hot Water	Green/White	Domestic Hot Water
Hot Water Circulating	Green/White	Domestic Hot Water Circulation
<u>Petroleum, Oil and Lubricant Systems</u>		
Diesel Oil	Brown/White	Diesel Oil

3.6 VALVE TAGS AND SCHEDULES

- A. Provide numbered brass tags on valves except at plumbing fixtures. Attach tags to valve stems with brass S-hooks or brass chain.
- B. Valves in medical gas systems shall be identified as required by NFPA 99-2018.
- C. Tags on new valves shall continue the numbering sequence of existing valves.
- D. Provide for each system a typewritten schedule of valves giving number, location (room number), and function of each with a small scale diagram outlining general piping layout and location of each numbered valves.

3.7 IDENTIFICATION OF EQUIPMENT

A. General:

1. Identification shall consist of upper case letters.
2. Each piece of equipment shall be appropriately identified by nameplates with 0.25" high letters.
 - a. Identification shall include the equipment designation and device function, e.g., Water Pressure Booster Pump, WPB-1.

3.8 MOTORS AND STARTERS

- A. Provide motors for equipment covered in Division 22 unless otherwise specified herein. Select motors for operation not exceeding a 1.0 service factor and within the nameplate amperage and nominal power rating.
- B. Provide starters, push buttons, thermal overload switches, and contactors for equipment covered in Division 22 unless otherwise specified herein.
- C. Provide 120 V secondary control power transformers for control circuits where equipment is served at 208 V or higher.

3.9 FUSES

- A. Provide fuses in equipment furnished under this Division of the specifications.
- B. Provide 3 spare fuses of each size, UL class, and voltage rating furnished under this Division of the specifications and turn over to the Owner. Obtain a receipt for same.

3.10 VIBRATION ISOLATION

A. General:

1. Provide vibration isolators for the following systems and source equipment: domestic water booster pumps.
2. Select and locate vibration isolators for uniform loading and deflection, according to weight distribution of piping and equipment.
3. Vibration isolators shall be installed and connected as specified herein or indicated on the Drawings, and in accordance with the manufacturer's written instructions, and approved submittal data.
4. Discrepancies between the specifications and field conditions, or changes required due to specific equipment selection, shall be brought to the attention of the Engineer prior to installation.
5. There shall be no direct contact of isolated piping and equipment with walls, floors, structural components, or any other non-isolated item.
6. Conflicts with other trades that will result in direct contact with isolated piping and equipment shall be brought to the attention of the Engineer prior to installation.
7. Vibration isolators shall not cause any change in position of piping and equipment, thus resulting in stresses or misalignments.
8. Isolated mounting systems for equipment shall permit equipment motion in all directions.
9. After installation, the vibration isolator manufacturer shall verify that vibration isolation systems are installed and operating properly, and shall submit a certificate so stating.

B. Floor Mounted Isolators:

1. For pipe stand supports at source equipment, install a Type NS (Neoprene Sandwich Pad) isolator between stand base and floor.
2. Verify that Type DN (Double Deflection Neoprene) isolators are bolted to the floor.

3. Provide neoprene bushings and washers when bolting floor mounted isolators to the floor or structure.
4. Type FS (Free Standing Spring) isolators.
 - a. Clean all foreign matter from between isolator springs, and equipment bottom and top of floor.
 - b. Verify that isolators are adjusted, with springs perpendicular to equipment bases, and adjustment bolts are tightened on equipment mountings.
 - c. Isolators shall not incorporate a leveling bolt of greater length than that supplied from the manufacturer.

C. Hanger Mounted Isolators:

1. Extent of hanger mounted isolators for domestic water piping from the source outlet shall be as scheduled:

<u>Pipe Diameter</u>	<u>Distance from Vibrating Equipment</u>
4" and smaller	50'
6" and larger	60'

2. The first 3 hangers from the source equipment shall be Type PSH (Pre-compressed Spring Hanger) and have the same minimum static deflection as the source equipment isolators up to a maximum of 2". The remaining isolator hangers shall be Type SH (Spring Hanger) and have a minimum 1" static deflection.
3. Install with housings as close to the structure frame as possible.
4. Verify that hangers are straight and not cocked.
5. Where hanger mounted isolators will be concealed by non-accessible ceilings, install the hangers immediately below the ceilings for access and maintenance.
6. Different piping requiring the same type of isolator with the same minimum static deflection may be supported on a common trapeze support that is isolated with the same type of isolators.
7. Vertical piping running between floors and located within the maximum distance as scheduled, shall use an extended riser clamp supported by 2 Type FS (Free-Standing Spring) isolators having a minimum 1" static deflection.

D. Piping In-line Isolators:

1. Provide at piping connections to source equipment where indicated on the Drawings.
2. Where the distance from the source equipment to the supply or discharge pipe is less than 5 times the hose diameter, provide a flexible metal hose with length to produce at least one 360 loop between connections.

3.11 EQUIPMENT AND EQUIPMENT ROOMS

- A. Remove dust, dirt, rust, stains, and temporary covers.
- B. Foreign matter shall be blown, vacuumed, flushed, or cleaned out of and from new equipment, fixtures, floor drains, piping, pumps, motors, bearings, devices, switches, controls, and panels.
- C. Clean and polish identification plates.
- D. In equipment rooms, clean equipment, insulation, piping, conduit, and room surfaces from dust and dirt and maintain in a clean condition from date of the Architect's final certificate until final completion of work and corrective work.
- E. Remove excess material from the Project site.

3.12 SEISMIC RESTRAINTS

- A. Restraints shall be installed after the equipment is mounted, piped, connected, and operating to ensure that no contact occurs during normal equipment operation.
- B. Installation of seismic restraints shall not cause any change of position of equipment or components resulting in stress and misalignment.
- C. No rigid connections between equipment or components and the building structure shall be made that degrade the vibration isolated system specified herein.
- D. Equipment that is internally vibration isolated and restrained shall have its entire unit assembly seismically attached to the structure.
- E. Do not brace a system to two different structures, such as a wall and a ceiling.
- F. After installation, manufacturer shall verify that seismic restraints are installed and operating properly, and shall submit a certificate so stating.

3.13 FOUNDATIONS

- A. Provide concrete foundations for the following floor-mounted equipment:

<u>Equipment</u>	<u>Foundation</u>
Water heaters	4" high pad
Water booster pumps	4" high pad

- 1. Foundation height shall accommodate seismic anchors, but shall be not less than the minimum specified above.
- B. Foundations shall be continuous and shall have beveled edges and smooth flat finish. Foundations shall be reinforced with No. 3 bars a maximum of 12" on center each way, and held in place with dowel rods at each corner anchored in the slab. Dowel rods shall not penetrate through the slab.
- C. Roughen and clean exposed slabs before pouring foundations. Apply bonding agent to surfaces in contact.
- D. Foundations shall extend a minimum of 6" beyond the equipment footprint or 1.5 times the seismic anchor embedment depth from the point of anchoring (whichever is larger) in all directions, including appurtenances, vibration isolators, base elbow supports, and motors.
- E. For equipment attached directly to foundations or inertia bases: and where equipment bases are provided with grout holes, or consist of a structural frame, shall have voids filled with grout after attachment to foundation.
- F. Fill voids between baseplates and foundations, and level equipment, with grout.

3.14 ACCESS PANELS - BUILDING

- A. Where plumbing work is concealed by walls or ceilings, or is inaccessible, provide an access panel to provide access for service and maintenance.

- B. Plumbing work located above ceilings is considered accessible if the ceiling is the accessible type and is arranged for access to the equipment.
- C. Fire-rated access panels shall be provided in fire barriers with ratings to match the construction fire rating.
- D. Installation of access panels is specified under another Division.

3.15 ESCUTCHEONS

- A. Provide escutcheons where exposed piping passes through walls, floors and ceilings in finished areas.

3.16 UNDERGROUND WARNING TAPE

- A. During backfill, install tape continuously along length of piping, 12" to 18" above the piping for:
 - 1. Diesel fuel.
 - 2. Domestic cold water.
 - 3. Rainwater.
 - 4. Soil.
 - 5. Waste.
 - 6. Utility located underground, not listed above.

3.17 PAINTING

- A. Except where otherwise specified herein, painting shall be done under another Division. Surfaces shall be left clean and free from oil.
- B. Equipment factory finishes damaged or deteriorated during construction shall be repaired to match original finish.
- C. Where galvanizing is broken during fabrication or installation, recoat exposed areas with zinc-rich paint.
- D. Exterior ferrous equipment, piping and supports shall be painted with 2 coats of rust preventive paint, color selected by the Architect.
- E. Conduits, insulation, pipe, hangers, and saddles visible through architectural openings shall be painted flat black.

3.18 EXCAVATION AND BACKFILLING

- A. General:
 - 1. As applicable to the building plumbing work, excavation, shoring, bracing, backfilling, and compaction shall conform to Division 31, Earthwork, except as superseded herein.
 - 2. The cutting and patching of hardscapes shall conform to Division 31, Earthwork.
 - 3. Determine exact location of existing underground utilities before excavation. Immediately repair any damage to existing underground utilities at the Contractor's expense.
 - 4. Install underground piping outside the building with 36" minimum cover, unless specified otherwise herein.
- B. Excavation:
 - 1. General:

- a. At minimum excavations shall comply with OSHA 29 CFR 1926.651-2019 and 29 CFR 1926.652-2019, or where applicable, an OSHA approved state plan.
 - b. Excavations shall be no longer or deeper than necessary.
 - c. When the excavated bottom contains rock or any similar material, excavate a minimum of 4" deeper than the required bottom grade, and restore with specified backfill material then compact.
 - d. When the bottom is over excavated, backfill to the required bottom grade with specified material then compact.
 - e. When the excavated bottom contains non-compactable soil and vegetation, refer to Division 31, Earthwork, for directions in removal and grade restoration.
 2. Piping:
 - a. Excavate to the pipe's bottom line and grade. Provide recesses for pipe hubs where applicable. Pipe barrels shall be laid full length on firm bedding.
 - b. For plastic piping, excavate 4" deeper than the bottom line and grade, then prepare for bedding backfill to restore pipe's bottom line and grade.
 3. Structures: excavate to 4" below the bottom grade as indicated on the structure's detail, and prepare for a bed of leveling backfill. Keep the excavation to within the minimum area needed to install or construct the structure.
- C. Backfilling:
 1. General:
 - a. Backfill material shall be free from rocks and debris.
 - b. Backfill material where applicable, shall be compactable to a minimum 95% Standard Procter Density.
 - c. At any settling of backfill, refill the void area, recompact, and leave level with adjacent grade.
 2. Backfill Material:
 - a. From excavated grade to 12" above pipe: compaction grade sand, crushed gravel, crushed stone, or rock dust.
 - b. From 12" above the pipe to finished grade: compaction grade sand, crushed gravel, crushed stone, rock dust, or excavated material free of rocks over 2" in diameter.
 - c. The top 18" under lawn and planting areas is required to be approved planting soil per Project's requirements.
 3. Backfill Requirements:
 - a. Install backfill evenly in layers not over 6" deep, compacting each layer.
 - b. Piping: work backfill material under each lower quarter of pipes, and along barrels, taking caution not to damage pipe material or coating.
 - c. Structures: apply backfill material around structures, and bring up to grade in even layers.
 4. Compaction:
 - a. Compaction inside buildings and in paved areas shall be a minimum 95% Standard Procter Density. In other areas it shall meet the compaction of the adjacent grade.
 - b. For all 95% compactions, a third party testing laboratory shall perform compaction test every 30', or fraction thereof, on piping runs, and at every 6' around structures.
 - c. Piping: use hand held tampers only around piping to 12" above the pipe. Above 12" hand guided electric tampers may be used. Do not use heavy compaction equipment or machinery which would displace or damage piping.
 - d. Structures: hand guided electric tampers may be used. Use caution not to damage the structure. Do not use heavy compaction equipment or machinery which would displace or damage structures.
 - e. Do not use water for compaction.

3.19 COORDINATION

- A. Provide offsets, transitions, and fittings to coordinate the work of each trade with that of other trades, including HVAC, fire suppression, electrical, structural, and architectural.

3.20 PHASING

- A. Install work in phases as required by the Architectural Documents.

3.21 OPERATION AND MAINTENANCE MANUALS

- A. These operation and maintenance manual requirements supplement operation and maintenance manual documentation requirements of other Sections of these specifications.
- B. Operation and maintenance documentation, in hardback 3-ring loose-leaf binders except full size drawings and CDs, shall cover the plumbing and fuel systems. Documentation shall include an operations and maintenance documentation directory, emergency information, operating manual, maintenance manual, test reports, and construction documents.
- C. The operation and maintenance documentation package shall be submitted as one comprehensive package to the Owner 3 months before systems start-up, and shall be updated, revised and completed at completion of, construction.
- D. Compile and coordinate the documentation for equipment and systems installed. Documentation shall be typewritten and shall contain, at a minimum, the following information.
 - 1. Introduction:
 - a. Project name, contractors' and subcontractors' names, addresses, and telephone and facsimile numbers.
 - b. Index.
 - 2. Operations and Maintenance Documentation Directory:
 - a. Explanation of the identification system used, including lists of systems, equipment, and component identifiers and names.
 - 3. Emergency Information:
 - a. Information for technical and nontechnical personnel about actions recommended during emergency situations to protect life and property and to minimize disruption to the building occupants. Emergencies shall, at a minimum, include:
 - 1) Fire.
 - 2) Security breach.
 - 3) Water outage.
 - 4) Power failure.
 - 5) Plumbing overflow or rupture.
 - 6) Heating failure.
 - 7) Cooling failure.
 - 4. Operating Manual:
 - a. General Information:
 - 1) Building function.
 - 2) Building description.
 - 3) Operating standards and logs.

- b. Technical Information:
 - 1) System description.
 - 2) Operating routines and procedures.
 - 3) Special procedures.
 - 4) Basic troubleshooting.
 - 5. Maintenance Manual:
 - a. Descriptions (specifications) of the equipment and components.
 - b. Description of function, as applicable: the function of the equipment, procedures before start-up, functional parameters (input, output) at the design load and at part loads, and performance verification procedures.
 - c. Recommended maintenance and lubrication procedures and their recommended frequency for this Project.
 - d. Recommended list of spare parts, part numbers, and the place(s) from which they can be obtained.
 - e. Original purchase order number; date of purchase; name, address, and the telephone number of the vendor; and warranty information.
 - f. Installation information.
 - g. Other information needed for the preparation of documents supporting the management of operation and maintenance programs.
 - 6. Test Reports and Certifications:
 - a. Copies of tests and certifications performed during manufacture and construction, including but not limited to the following:
 - 1) Certification of installation of vibration isolation.
 - 2) Certification of seismic restraints.
 - 3) Receipt for spare fuses.
 - 4) Receipt for instruction of operating personnel.
 - 5) Certification of plumbing piping tests.
 - 6) Results of domestic water system disinfection tests.
 - 7) Corrosion control survey report for buried ferrous piping.
 - 8) Fuel tank installation checklist.
 - 7. Construction Documents:
 - a. Record drawings.
 - b. Approved submittals, including revised shop drawings indicating as-installed conditions.
 - c. Equipment identification charts and schedules.
 - d. Warranty certificates.
 - e. Inspection certificates.
 - f. Performance verification report.
 - E. Submit a receipt signed by the Owner acknowledging receipt of the operation and maintenance documentation package.
 - F. Provide metal cabinets mounted on the wall of the mechanical room to house the operation and maintenance documentation package. Cabinets shall be approximately 12" wide x 18" high x 6" deep constructed of 18 gauge sheet metal with hinged door with latch. Cabinets shall be painted black and shall be labeled with 0.5" stenciled letters.
- 3.22 RECORD DRAWINGS
- A. Refer to Section Project Record Documents, 017839.

3.23 MAINTENANCE

- A. Equipment operated prior to the date of the Architect's final certificate shall be maintained in accordance with manufacturer's recommendations.
- B. Prepare and submit a lubrication chart listing for each piece of equipment:
 - 1. Points requiring lubrication.
 - 2. Recommendations for a single manufacturer's lubricants with brand name and designation.
 - 3. Frequency of lubrication required.
- C. Lubricate each item of apparatus requiring lubrication prior to start-up in accordance with the manufacturer's recommendations.

3.24 INSTRUCTION OF OPERATING PERSONNEL

- A. Provide the designated Owner's personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of equipment specified in Division 22. Conduct 2 formal instruction sessions for operating personnel. The first session shall be conducted at the time of start-up and check-out, and the second session shall be approximately 2 months later. Sessions shall be a minimum of 2 days for basic plumbing systems, and as specified herein for specialty systems and equipment. Sessions shall be conducted at the site.
- B. Prepare and submit a syllabus describing an overview of the proposed training program, describing how the training program will be conducted, when and where meetings are to be held, names and company affiliations of lecturers, description of contents and outline for each lecture, and recommended reference material and outside reading. Obtain direction from the Owner on which operating personnel shall be instructed in each system. Proposed training schedules, materials, and lesson plans shall be submitted to the Owner for review of the content and adequacy of the training of the Owner's personnel.
- C. The appropriate manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor, or manufacturer's representative. More than one party may be required to execute the training. The training program shall include the following, as appropriate for the system or equipment:
 - 1. Training shall normally start with classroom sessions followed by hands-on training for each piece of equipment, which shall illustrate the various modes of operation, including start-up, shutdown, and power failure.
 - 2. During any demonstration, should the system fail to perform in accordance with the requirements of the operation and maintenance manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
 - 3. Training shall include:
 - a. Use of the printed installation, operation and maintenance instruction material included in the operation and maintenance manuals.
 - b. A review of the written operation and maintenance instructions emphasizing safe and proper operating requirements, preventative and routine maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover, and any emergency procedures.
 - c. Discussion of relevant health and safety issues and concerns.
 - d. Discussion of warranties and guarantees.
 - e. Common troubleshooting problems and solutions.
 - f. Explanatory information included in the operation and maintenance manuals and the location of plans and manuals in the facility.
 - g. Discussion of any peculiarities of equipment installation or operation.

- h. Classroom sessions shall include the use of overhead projections, slides, video/audio-taped material as appropriate.
- i. Factory-trained technicians shall give instruction on the following specialty systems and equipment:

<u>System/Equipment</u>	<u>Minimum Session Duration, hours</u>
Drainage systems	3
Water systems	4
Water pressure booster systems	2
Backflow preventers	1
Domestic hot water system	2
Domestic hot water circulation system	1
Fuel systems	2

- 4. Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment.
- 5. Explain and demonstrate the operation, function and overrides of local packaged controls not controlled by the central control system.
- 6. Training shall occur after testing is complete, unless approved otherwise by the Owner.
- 7. Provide DVD format video recordings of training sessions and a complete record copy of training materials, handouts, and other printed materials used in each training session.
- 8. Obtain a receipt acknowledging completion of each item of instruction.

END OF SECTION 220010

COVER SHEET FOR
SUBMITTALS TO NEWCOMB & BOYD

Project: _____ Date: _____

Item: _____ Submittal Number: _____

Manufacturer: _____ Model: _____

Specification Paragraph and/or Drawing Number: _____

Capacity: _____

Electrical Characteristics (including identification of all separate connections or services required): _____

Accessories: _____

Options: _____

Deviations (if any; if none, state so): _____

General Contractor Approval: _____

SECTION 220090 – PLUMBING PERFORMANCE VERIFICATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other plumbing systems are specified in other Sections of Division 22.
- B. Refer to Section 220010, Plumbing General for a list of plumbing Sections included in this specification.
- C. This Section covers plumbing systems performance verification, as required to demonstrate that the equipment and systems of Division 22 are ready for safe and satisfactory operation, as defined by the Construction Documents. Performance verification shall include, but shall not be limited to, identification of piping and equipment, cleaning, lubrication, start-up, check-out, and testing and adjusting systems, preparation of equipment and systems documentation and of maintenance and operation manuals, Owner training, and preparation of record drawings.
- D. Performance verification is an ongoing process and shall be performed throughout construction. Performance verification verifies that systems are operating in a manner consistent with the Construction Documents.
- E. The general requirements of the commissioning process and the duties of the Commissioning Authority are detailed in Section 290010, Commissioning. Become familiar with the requirements and coordination obligation of Section 290010, Commissioning and the commissioning schedule issued by the Commissioning Authority as they apply to the work of Division 22, and execute the performance verification responsibilities within the commissioning process as specified therein.
- F. Performance verification shall conclude with the completion of required deferred testing, training, and system documentation as specified herein and required to demonstrate the proper operation of the plumbing equipment and systems provided by this Division.
- G. Verify, at a minimum, the performance of the following systems and equipment and witness the following tests:
 - 1. Section 220010, Plumbing General:
 - a. Seismic restraints.
 - b. Variable frequency drives.
 - c. Vibration isolation.
 - 2. Section 224200, Plumbing Fixtures:
 - a. Fixture tests.
 - b. Plumbing fixtures.
 - 3. Section 224300, Drainage Systems:
 - a. Piping and joint tests.
 - b. Rainwater and Secondary Rainwater systems.
 - c. Sanitary, waste and vent system.
 - d. Sump pumps.
 - 4. Section 224400, Water Systems:
 - a. Flow and balancing valves.
 - b. Backflow preventers.
 - c. Freezeproof hydrants.
 - d. Hot water circulating pumps and system.

- e. Mixing valves.
 - f. Piping and joint tests.
 - g. Pressure reducing valves.
 - h. Thermal expansion tanks.
 - i. Trap primers.
 - j. Vacuum breakers.
 - k. Water heaters.
 - l. Water meters.
 - m. Water pressure booster systems.
5. Section 224900, Petroleum, Oil and Lubricant Systems:
- a. Fuel piping.
 - b. Fuel system status panels.
 - c. Fuel tanks and accessories.
 - d. Leak detection systems.
 - e. Piping and joint tests.

1.2 QUALITY ASSURANCE

- A. Provide a Plumbing Performance Verification Supervisor with ten years experience in plumbing contracting. The Plumbing Performance Verification Supervisor shall become familiar with the Owner's project requirements and the requirements of the performance verification process as defined in this Section and if applicable, the commissioning process defined in Division 29. The Plumbing Performance Verification Supervisor shall coordinate and execute the required performance verification activities.
- B. The Plumbing Performance Verification Supervisor shall review submittal data for conformance with the requirements of the Project, shall monitor compliance with the requirements specified herein for storage and protection of equipment during construction, shall authorize the initial starting of equipment and systems in a manner to avoid damage to equipment, shall oversee start-up, testing and balancing, and shall document that the scheduled and specified performance requirements of each system have been accomplished.
- C. Refer to ASHRAE Guideline 0.2-2015, Commissioning Process for Existing Systems and Assemblies, and Guideline 4-2019, Preparation of Operating and Maintenance Documentation for Building Systems.

1.3 PERFORMANCE VERIFICATION RESPONSIBILITIES

- A. The Plumbing Performance Verification Supervisor shall be responsible for scheduling, supervising, and coordinating and executing the start-up, testing, and performance verification activities as specified herein. Include and itemize the cost of performance verification in the contract price, and in each purchase order or subcontract written, include requirements for submittal data, performance verification efforts and documentation, operations and maintenance data, and training as specified herein.
- B. Plumbing performance verification shall take place in three phases. Performance verification requirements for each phase are as follows:
 - 1. Construction Phase:
 - a. Attend a performance verification scoping meeting and additional such meetings, initially scheduled monthly until prefunctional testing of equipment and systems begins, and weekly thereafter during the construction phase to facilitate the performance verification process. The Plumbing Performance Verification Supervisor shall coordinate meeting attendance with the Commissioning Authority.
 - b. Report in writing to the Commissioning Authority at least as often as performance verification meetings are scheduled, concerning the status of plumbing activities as they

affect the performance verification process, the status of each discrepancy identified the prefunctional and functional testing process, explanations of any disagreements with the identified deficiencies, and the proposed resolution and schedule for correction of the deficiency.

- c. Provide documentation of installed systems and equipment, and develop functional testing procedures. This documentation shall include detailed manufacturer installation, start-up, operating, troubleshooting and maintenance procedures; full details of any Owner-contracted tests; pump curves; full factory testing reports, if any; and full warranty information, including responsibilities of the Owner to keep the warranty in force. In addition, the installation, start-up and check-out materials that are actually shipped inside the equipment and the actual field check-out sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Authority.
- d. Develop and submit to the Commissioning Authority for review and comment, prior to equipment or system start-up, a complete start-up and initial check-out plan using manufacturer's start-up procedures and prefunctional checklists for the performance of the equipment to be verified.
- e. Assist in clarifying the proposed operation and control of equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
- f. Prepare the specific functional test procedures as specified herein and review the proposed functional test procedures to ensure feasibility, safety, and equipment protection, and provide necessary written alarm limits to be used during the tests. Obtain Commissioning Authority approval for proposed functional test procedures.
- g. Prepare a preliminary schedule for performance verification activities, including pipe and system pressure and leakage testing, flushing and cleaning, equipment start-up, and testing, and update the schedule during the construction period, as appropriate. Notify the Commissioning Authority immediately when the performance verification activities not yet performed or not yet scheduled will delay construction.
- h. Plumbing equipment start-up shall not be initiated until completion of pressure and leakage testing and cleaning as specified in other Sections of Division 22.
- i. Provide start-up and prefunctional testing for equipment and execute the plumbing-related portions of the prefunctional checklists for the verification of the performance of all the equipment during the start-up and initial check-out process.
- j. Perform and document start-up and system operational check-out procedures, providing a copy to the Commissioning Authority.
- k. Correct noncompliance items before beginning functional performance testing. Water testing and adjusting shall be completed with discrepancies and problems remedied before functional testing of the respective water-related systems.

2. Acceptance Phase:

- a. Place equipment and systems into operation and continue their operation during each working day of the testing, adjusting and balancing, and performance verification activities, as required.
- b. For each system or area, have required prefunctional checklists, calibrations, start-up and prefunctional tests of the plumbing systems and associated controls completed prior to beginning the testing, adjusting and balancing process.
- c. Provide skilled technicians to execute starting and prefunctional testing of equipment and to execute the functional tests for each individual piece of equipment and system. Technicians shall be available and present during the agreed upon scheduled tests and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
- d. Perform functional testing for specified equipment and interpret the test data, as necessary under the direction of the Commissioning Authority.
- e. Correct deficiencies (differences between specified and observed performance) as identified by the Plumbing Performance Verification Supervisor or the Commissioning Authority and

- interpreted by the Engineer and retest the equipment, as required to demonstrate proper operation and performance.
- f. Prepare operation and maintenance manuals as specified herein, including clarifying and updating the original sequences of operation to as-built conditions.
 - g. Maintain marked-up record drawings and produce final record drawings of Project drawings and contractor-generated coordination drawings. List and identify on these record drawings the locations of control system components, and sensor installations that are not equipment mounted.
 - h. Provide specified training of the Owner's operating personnel.
 - i. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
3. Warranty Period:
- a. Execute deferred functional testing.
 - b. Correct deficiencies and make necessary adjustments to operations and maintenance manuals and as-built drawings system or equipment modifications made during the warranty period and those identified in any deferred functional performance testing.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Standard testing equipment required to perform start-up, initial check-out, prefunctional, and required functional testing shall be provided for the equipment or system being tested.
- B. Test equipment shall be of the quality and accuracy required to test and/or measure system performance with the tolerances specified and shall have been calibrated within the last 12 months, or as specified herein. Equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates available on request.
 - 1. Temperature sensors and digital thermometers shall have a certified calibration within the past 12 months and a resolution of $\pm 0.1^{\circ}\text{F}$. Accuracy of temperature test equipment shall be at least twice that of the instrumentation being tested.
 - 2. Pressure sensors shall have a certified calibration within the 12 months and a resolution of 0.05% of sensor range. Accuracy of pressure test equipment shall be at least twice that of the instrumentation being tested.
 - 3. Accuracy of other sensors shall be at least twice that of the instrumentation being tested.

PART 3 - EXECUTION

3.1 SUBMITTALS

- A. Submit additional documentation as required to support the performance verification process. This additional submittal documentation shall include, at a minimum, the proposed start-up and initial check-out procedures, and prefunctional checklists.

3.2 START-UP PLAN AND PREFUNCTIONAL TESTING

- A. Prefunctional testing shall be required for each piece of equipment to ensure that the equipment and systems are properly installed and ready for operation, so that functional testing may proceed without delays. Follow the approved start-up, initial check-out, and prefunctional testing procedures. Sampling strategies shall not be used for prefunctional testing. The prefunctional testing for equipment and subsystems of a given system shall be successfully completed and documented prior to functional testing of the system.

- B. Procedures for performance verification shall include:
1. Start-up and initial check-out plan: develop the detailed start-up and prefunctional testing plans for equipment and systems that are to be performance verified, as specified herein. Review the proposed procedures and prefunctional testing documentation to ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed.
 2. The start-up and initial check-out plan shall consist, as a minimum, of the following:
 - a. The manufacturer's standard written start-up and check-out procedures copied from the installation manuals and manufacturer's normally used field check-out sheets. The plan shall include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan.
 - b. First-run checklist for equipment, including:
 - 1) Equipment properly set.
 - 2) Alignment of shafts and couplings.
 - 3) Adjustment of vibration isolators.
 - 4) Piping and equipment properly connected.
 - 5) Completion of initial lubrication procedures.
 - 6) Wiring properly connected.
 - 7) Electrical overload relays appropriate for load.
 - 8) Electrical accessories properly installed and adjusted.
 - 9) Controls, safeties, and time switches properly set.
 - 10) Verification of direction of motor rotation after final electrical connections by jogging motor.
 - 11) Measurement of ampere draw of electric motors and comparison with nameplate rating and with overload heater ratings.
 - 12) Monitoring of temperature build-up in motors and bearings.
 - c. Contractor-developed prefunctional checklists.
 3. Identify which entity is responsible for executing and documenting each of the line item tasks and note that trade on the form. Each form may have more than one trade responsible for its execution.
- C. Four weeks prior to start-up, schedule equipment and systems start-up and check-out and notify the Commissioning Authority in writing. The execution of the prefunctional checklists, start-up and check-out shall be directed and performed by the Contractor, in accordance with manufacturer's published procedures. The Commissioning Authority shall be present for the start-up, check-out, and prefunctional testing of the first unit of each type of equipment, and any other tests he designates.
- D. Sensor calibration: calibration of sensors associated with a given piece of equipment or system shall be included as part of the prefunctional testing and listed on the appropriate test checklists and reports for the system.
- E. Completed start-up, check-out, and prefunctional test forms shall be completed and submitted to the Commissioning Authority for review. List outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies shall be provided to the Commissioning Authority within 2 days of test completion. The Commissioning Authority shall review the Contractor's start-up and prefunctional testing reports and shall submit either a noncompliance report or an approval form to the Contractor. The Contractor shall correct items that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the Commissioning Authority as soon as outstanding items have been corrected and resubmit an updated start-up report and a statement of correction on the original noncompliance report. When requirements are completed, the Commissioning Authority shall recommend approval of the start-up and prefunctional testing of each system and schedule the functional testing of the equipment or system.

- F. Complete start-up and prefunctional testing for a system before functional test of that system may proceed.

3.3 RETESTING OF EQUIPMENT AND/OR SYSTEMS

- A. Provide labor and materials required for retesting of any functional test found to be deficient.
- B. Prior to retesting, submit required data indicating that the deficient items have been completed and/or corrected to the Commissioning Authority for approval and rescheduling of the functional test. If during the retesting it becomes apparent that the deficient items have not been completed and/or corrected as indicated in the data provided by the Contractor, the retesting shall be stopped. Costs for the design team to further supervise the retesting of a functional test shall be the responsibility of the Contractor.

3.4 DEFERRED TESTING

- A. Schedule and coordinate, with the approval of the Commissioning Authority, tests delayed until building construction is completed, required building occupancy or loading, weather, or other conditions are suitable for the demonstration of equipment or system's performance, as specified herein. Deferred testing shall be executed, documented, and deficiencies corrected as specified herein for functional testing.

3.5 TESTING DOCUMENTATION, NONCONFORMANCE, AND APPROVALS

- A. List outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the functional test procedure forms or on an attached sheet. The functional test procedure forms and any outstanding deficiencies shall be provided to the Commissioning Authority within 2 days of test completion. The Commissioning Authority shall review the Contractor's start-up and prefunctional testing documentation and shall submit either a noncompliance report or an approval form to the Contractor. Work with the Commissioning Authority to correct and retest deficiencies or uncompleted items. Correct items that are deficient or incomplete in a timely manner and notify the Commissioning Authority as soon as outstanding items have been corrected and resubmit an updated start-up report and a statement of correction on the original noncompliance report. When requirements are completed, schedule the functional testing of the equipment or system.
- B. As functional performance testing progresses and deficiencies are identified, work with the Commissioning Authority to resolve the issues.

3.6 OPERATION AND MAINTENANCE MANUALS

- A. The Plumbing Performance Verification Supervisor shall compile and prepare documentation for equipment and systems covered in Division 22 and deliver this documentation for inclusion in the operation and maintenance manuals prior to the training of the Owner's personnel.

3.7 INSTRUCTION OF OPERATING PERSONNEL

- A. The Plumbing Performance Verification Supervisor shall schedule, coordinate and assemble, and deliver the documentation of training required by Division 22.

3.8 FUNCTIONAL TESTS

- A. Functional test requirements for the demonstration of proper system and equipment operation shall be defined by the Plumbing Performance Verification Supervisor. Execution of these test and demonstration of the required performance shall be the responsibility of the Contractor under the direction of the Commissioning Authority.

- B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or subsystems at the discretion of the Commissioning Authority. Beginning system testing before full completion of construction shall not relieve the Contractor from fully completing the system, including prefunctional checklists.
- C. Functional testing shall be completed and test documentation approved by the Commissioning Authority before the Project will be considered substantially complete.

END OF SECTION 220090

SECTION 222500 – PLUMBING INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other plumbing systems are specified in other Sections of Division 22.
- B. Refer to Section 220010, Plumbing General, for a list of plumbing Sections included in this specification.
- C. This Section covers thermal insulation for plumbing piping and equipment.
- D. Items not to be insulated:
 - 1. Chrome plated water supplies to plumbing fixtures. See Section 224200, Plumbing Fixtures for insulation of water supplies to ADA fixtures.
 - 2. Underground domestic cold water piping.
 - 3. Vents from pressure relief valves.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. North Carolina State Energy Conservation Code-2018.
 - 2. North Carolina State Plumbing Code-2018.
 - 3. International Energy Conservation Code-2009.
- B. Products of the manufacturers listed will be acceptable for use for the specific functions specified herein. Materials shall be compatible with the materials to which they are applied, and shall not corrode, soften or otherwise attack such material in either the wet or dry state.
- C. Materials shall be applied subject to their temperature limits. Methods of application of insulating materials or finishes not specified in detail herein shall be in accordance with the particular manufacturer's published recommendations.
- D. Insulation shall be applied by experienced workers regularly employed for this type of work.

1.3 RATINGS

- A. Insulation and accessories, unless specifically excepted herein, shall have a maximum composite flame spread rating of 25 and a maximum smoke developed rating of 50. Materials that are factory-applied shall be tested as assembled. Materials which are field-applied may be tested individually. No fugitive or corrosive treatments shall be employed to impart flame resistance.
- B. Flame spread and smoke developed ratings shall be in accordance with ASTM E84-2019b. Products or their shipping cartons shall bear a label indicating flame spread and smoke developed ratings.
- C. Treatment of pipe jackets to impart flame and smoke safety shall be permanent. The use of water-soluble treatments is prohibited.
- D. Vapor retarders shall have a maximum permance of 0.02 perm at 73.4°F.

1.4 ALTERNATE THICKNESSES

- A. Specified thicknesses may be increased or reduced for insulation materials having thermal resistivity, K-values, different from those listed. Submit calculations in accordance with ASHRAE/IES 90.1-2019, and documentation of product performance.

PART 2 - PRODUCTS

2.1 INSULATION

- A. Fiberglass Pipe and Blanket Insulation:
 - 1. Pipe insulation: maximum K-value for preformed pipe insulation: $0.23 \text{ Btu}\cdot\text{in}/(\text{h}\cdot\text{ft}^2\cdot^\circ\text{F})$ at 75°F .
 - a. Manufacturer: CertainTeed, Johns Manville, Knauf, Manson Insulation, or Owens Corning.
 - 2. Blanket insulation: maximum K-value for blanket insulation: $0.28 \text{ Btu}\cdot\text{in}/(\text{h}\cdot\text{ft}^2\cdot^\circ\text{F})$ at 75°F .
 - a. Manufacturer: CertainTeed, Johns Manville, Knauf, Manson Insulation, or Owens Corning.

2.2 ACCESSORIES

- A. Adhesives and Mastics:
 - 1. Manufacturer: Aeroflex, Armacell, Childers, Epolux, Foster, Marathon, Pittsburgh Corning PC 88, Pittsburgh Corning Pittcote 300 (interior) or 404 (exterior), or Vimasco.
- B. Insulating Cement:
 - 1. Mineral wool type, asbestos free, maximum K-value of $0.20 \text{ Btu}\cdot\text{in}/(\text{h}\cdot\text{ft}^2\cdot^\circ\text{F})$ at 75°F .
 - 2. Manufacturer: Industrial Insulation Group CalCoat-127, or Ramco Ramcote 1200.
- C. Glass fabric: 10 x 10 threads per square inch construction white fiberglass scrim fabric.
- D. Tape: pressure sensitive, foil-scrim-kraft backed.
- E. PVC Fitting Jackets:
 - 1. High impact, UV resistant, 30 mil thick, white polyvinyl chloride (PVC) fitting jackets with formaldehyde-free insulation inserts, and stainless steel attachments. Provide additional insulation inserts as required for larger pipes. Flame and smoke ratings shall comply with Paragraph 1.04, Ratings.
 - 2. Manufacturer: Johns Manville Zeston 2000 PVC, or Knauf Proto.
- F. Coal Tar:
 - 1. Self-priming, cold-applied type.
 - 2. Manufacturer: Koppers Bitumastic 50.

2.3 ALUMINUM JACKETING

- A. Piping and tanks: corrugated aluminum jackets, 0.016" thick with an embossed finish, and a factory heat laminated 3 mil moisture retarder film on the inner surface, and meeting ASTM B209-2014.
- B. Fittings: stamped 2-piece (matching halves) aluminum fitting covers and end caps, 0.024" thick, with a factory heat lamination moisture retarder film on the inner surface.

PART 3 - EXECUTION

3.1 GENERAL

- A. Surfaces to be insulated shall be clean, dry, and free of foreign material, rust, scale and dirt when insulation is applied.
- B. Perform pressure and leakage tests and submit results required by other Sections before applying insulation.
- C. Where existing insulation is damaged due to the new work, repair damage to match existing work or replace damaged portion with insulation specified for new work.
- D. On piping where temperature maintenance cable is specified, to ensure the insulation's adequate fit, increase the insulation size as required to comply with the cable manufacturer's installation instructions.

3.2 INSULATION FOR TEMPERED, HOT, AND HOT WATER CIRCULATING PIPE

- A. Insulate the following pipe with preformed fiberglass pipe insulation of the thickness indicated, with vapor retarder and white all service jacket with self-sealing lap:

	Fluid Design Operating Temperature Range, °F	<u>Insulation Thickness, Inches</u>	
		<u>0.5"- 1.25"</u>	<u>1.5"- 6"</u>
Hot water and hot water circulating	110 to 140	1	1.5
High temperature hot water	141 to 180	1.5	2

- 1. Install insulation with jacket drawn tight and side laps and end joint butt strips secured. End joint butt strips shall be minimum 3" wide and of material identical to jacket. Seal ends of insulation at fittings, valves, and riser clamps.
- B. Insulate fittings, flanges, strainers, unions, and valve bodies with packing nut and stem left open, with preformed or mitered fiberglass. Wire fiberglass in-place and cover with a smoothing coat of insulating cement. Finish with glass fabric embedded into a coat of white breather mastic. Glass fabric shall overlap adjoining insulation at least 2".
 - 1. Cover exposed fittings with glass fabric and mastic.

3.3 INSULATION FOR COLD PIPE

- A. Insulate the following pipe with preformed fiberglass pipe insulation of the thickness indicated, with vapor retarder, white all service jacket, and self-sealing lap:

Domestic cold water above grade, 0.5" thick.
 Water cooler waste, trap, and waste arm to vertical stack, 1" thick.
 Chilled drinking water, supply and return, 1" thick.
 Branch waste, including drain and P-trap, receiving drainage from air conditioning and boiler equipment, 1.5" thick.

Exposed horizontal rainwater, and secondary (emergency overflow) rainwater, including connections to roof drains and vertical leaders within the top floor, 1" thick.

1. Install insulation with jacket drawn tight with side-laps and end joint butt strips secured. End joint butt strips shall be same material as jacket, and not less than 3" wide. Seal ends of insulation at fittings, valves, and riser clamps.
- B. Insulate fittings, flanges, strainers, unions, and valve bodies with packing nut and stem left open, with preformed or mitered fiberglass. Wire fiberglass in-place and vapor seal with a layer of glass fabric embedded between two 0.063" coats of white vapor retarder mastic. Glass fabric shall overlap adjoining insulation at least 2".

3.4 ACCESSORIES

- A. Adhesives and Mastics:
 1. Seal open ends of insulation with a thick mastic coating.
- B. Insulating Cement:
 1. Install a minimum 0.5" thick coat with a smooth finish, and even with the adjacent insulation.
- C. Glass Fabric:
 1. For piping fittings and valves use tape form and for water storage tanks use sheet form.
- D. Tape:
 1. When applied to jacket insulation, wrap tape as tight as possible without crushing the insulation jacket.
- E. Fitting Jackets:
 1. Installation in mechanical rooms and exterior locations only.
- F. Coal Tar:
 1. Apply to underground piping to:
 - a. Isolate copper from masonry or concrete flooring.
 - b. Repair slightly damaged pipe-wrap for gas piping.
 - c. Repair slightly damaged cellular glass insulation jacketing.

3.5 INSTALLATION

- A. Install insulation after piping has been tested and approved.
- B. Insulation shall be clean and dry during installation and during application of any finish.
- C. Provide removable and replaceable covers on equipment, and removable ends of strainers requiring insulation, that must be opened periodically for inspection, cleaning, or repair.
- D. Install insulation materials with smooth and even surfaces, jackets drawn tight and cemented down smoothly at longitudinal and end laps. Do not use scrap pieces of insulation where a full length section will fit.

- E. Install insulation, jackets and coatings continuous through openings and sleeves in nonrated construction. For penetrations of fire- or smoke-rated construction, insulation shall be butted tightly against firestops specified in Section 220010, Plumbing General. Tape butt joints.
- F. Banding wires shall have the twisted terminals turned down toward the insulation without damaging the vapor retarder.

3.6 INSULATION PROTECTION

- A. Protect interior fiberglass piping insulation exposed to damage with a corrugated aluminum jacket. Locate the longitudinal joints to shed water, and secure with aluminum bands at end joints and every 12" on center. Tightly abut end joints together. Install aluminum fitting-covers over fittings, overlapping the adjacent butt ends of the piping's aluminum jacket. Secure with aluminum bands.
- B. Protect interior site insulated tanks with a corrugated aluminum jackets. Install jacketing taut around tank overlapping seams by 3", and tightly abutting end joints together. Secure with aluminum bands at end joints and every 12" on center.
- C. Protect exterior piping insulation, except flexible elastomeric, with a corrugated aluminum jacket. Locate the longitudinal joints to shed water, and secure with aluminum bands at end joints and every 12" on center. Provide a 2" overlap at each end joint and seal with joint sealant. Install aluminum fitting-covers over fittings, overlapping the adjacent butt ends of the piping's aluminum jacket. Seal with joint sealant, and secure fitting covers with aluminum bands.
- D. Protect exterior flexible elastomeric insulation with a UV resistant white acrylic latex coating.

END OF SECTION 222500

SECTION 224200 – PLUMBING FIXTURES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other mechanical systems are specified in other Sections of Division 22.
- B. Refer to 220010, Plumbing General, for a complete list of plumbing sections included in this specification.
- C. This Section covers plumbing fixtures, trim and related equipment.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. All applicable codes referenced in 220010, Plumbing General.
 - 2. ICC A117.1-2017 for Accessible and Usable Buildings and Facilities.
 - 3. Americans with Disabilities Act (ADA) - 1990 (Revised 2016).
 - 4. Safe Drinking Water Act-2018.
 - 5. Wetted components in the potable water (fixture) system, where the water is anticipated for human consumption shall comply with the Reduction of Lead in Drinking Water Act – 2011.

1.3 PLUMBING FIXTURES - GENERAL

- A. Fixtures shall have smooth impervious surfaces, free from defects with no concealed fouling surfaces, and be Grade-A quality. Fixtures shall comply with ASME A112.19.1/CSA B45.2-2018, ASME A112.19.2/CSA B45.1-2018, ASME A112.19.3/CSA B45.4-2017, and ASME A112.19.5/CSA B45.15-2017. The name or trademark of the manufacturer is required to be printed on or pressed into the fixtures. In addition, a label which cannot be removed without destroying it, containing the manufacturer's name or trademark, and the quality or class of the fixture, shall be affixed to fixtures and not removed until after the work is accepted.
- B. Exposed waste and supply piping, including piping exposed when millwork doors are open, and mounting bolts of fixtures shall be chromium-plated.
- C. All faucets, flush valves, and associated trim shall be chromium-plated.
- D. Fixtures and trim of the same construction shall be by the same manufacturer, e.g., vitreous china, water fountains, stainless steel, flush valves, and supplies, etc., unless otherwise specified herein.
- E. Vitreous china fixtures shall be white.
- F. Plumbing fixtures shall be complete, with installation, and all fittings, trim, and equipment to provide for proper operation and usage, as defined by the product manufacturers, industry standards, and applicable codes.

1.4 PLUMBING RELATED FIXTURES AND EQUIPMENT

- A. Laundry equipment is specified in another Division.

PART 2 - PRODUCTS

2.1 WATER CLOSETS AND TRIM

A. Fixtures:

1. F1A, Water Closet - Wall Type, Flush Valve, Regular Use:
 - a. Elongated vitreous china wall type, with siphon jet bowl, flush valve and trim for 1.28 gal per flush, seat, chair carrier, and chromium-plated nuts and washers.
 - b. Manufacturer: American Standard 2257.101, Kohler K-4325, Sloan ST-2059-A, or Toto CT708E.
2. F1B, Water Closet - Wall Type, Flush Valve, ADA Use:
 - a. Elongated vitreous china wall type, with siphon jet bowl, flush valve and trim for 1.28 gal per flush, seat, chair carrier, and chromium-plated nuts and washers.
 - b. Manufacturer: American Standard 3351.001, Kohler K-4325, Sloan ST-2059-A, or Toto CT708E.

B. Flush Valves:

1. Flush Valve – Sensor, 1.28 GPF Hard-Wired, Trap Primer:
 - a. 1.28 gal per flush, with sweat adapter kit, solid ring pipe support, back check angle stop valve, vacuum breaker, and hard-wired infrared sensor for automatic operation, including transformer, wiring, trap primer fitting, override button, and 11" rough.
 - b. Manufacturer: Kohler K-7531 or approved equal.

C. Water Closet Seats:

1. Seat - Elongated, Heavy Weight:
 - a. Solid high impact plastic with open front seat, stainless steel posts, washers and nuts, check hinges, and antimicrobial agent.
 - b. Manufacturer: Bemis 2155C, or Church 2155C.

D. Floor-Mounted Carriers:

1. Carrier - Commercial Type:
 - a. For wall-hung water closets: commercial type with a 500 lb supported weight capacity, adjustable vertically and horizontally from the faceplate, with base support, adjustable coupling, gasket, and chromium-plated through-bolts and acorn nuts.
 - b. Manufacturer: Josam, Smith, Wade, or Zurn.

2.2 LAVATORIES AND TRIM

A. Fixtures:

1. F2A, Lavatory - Countertop Undermount Type, Regular/ADA Use:
 - a. Vitreous china lavatory, nominal 21"x17" oval and fitted with counter-mounted faucet, supplies with stop valves, drain, P-trap, waste to wall, and escutcheons.
 - b. Manufacturer: American Standard 0497.221, Kohler K-2211, Sloan SS-3001, or Toto LT597.4.

2. F2B, Lavatory - Wall Type, ADA Use:
 - a. Vitreous china lavatory, 20"x18", with 4" centers and fitted with faucet, supplies with stop valves, grid drain, P-trap, waste to wall, escutcheons, and floor-mounted carrier.
 - b. Manufacturer: American Standard 0355.012, Kohler K-2005, Sloan SS-3003, or Toto LT307.4.
3. Faucet – Electronic, Hard-Wired, Curved Spout, Regular/ADA Use:
 - a. Electronic type with polished chromium-plated brass body, self-adjusting hard-wired infrared sensor, vandal resistant curved spout, base plate for 4" centers, and 0.5 gpm vandal resistant aerator flow control. Provide each faucet with an ASSE-1070 water mixing valve for nominal 109°F outlet temperature, cold and hot water inlets, integral checks, waterproof electronics with 10 sec wash cycle, a 2 sec maximum run-on time, transformer and installation hardware. The assembly shall comply with ASME A112.18.1/CSA B125.1-2018 and ICC A117.1-2017.
 - b. Manufacturer: Chicago 116.101.AB.1/131-ABNF/240.631.00.1/240.627.21.1, Sloan ETF-600-BDT/EL-154, or Zurn Z6915-CWB-F-TMV-1/P6900-HW6-XL.
- B. Supplies:
 1. Supplies – Wheel Handle Control:
 - a. Angle stops with 0.5" id x 5" inlet sweat tube, bell escutcheon, wheel handle control, 0.375" od x 12" flexible tube riser, and chromium-plated exposed piping and parts.
 - b. Manufacturer: Just JL26, Keeney 2100PCL12LF, McGuire LF170 ECO, or Zurn Z8808-XL-LR.
- C. Drains:
 1. Drain – Grid Type:
 - a. Grid type with chromium-plated cast brass top and strainer, and 1.25" 17 gauge tailpiece.
 - b. Manufacturer: Just JSG7, Keeney 5680PCCR, McGuire 155A ECO, or Zurn Z8743-PC.
- D. P-traps:
 1. P-trap – 1.25", Cleanout Plug:
 - a. 1.25" tubular chromium-plated brass, with cast brass slip nuts, cleanout plug, minimum 2" water seal, 17 gauge tubing drain to wall, and wall flange.
 - b. Manufacturer: Just JT125, McGuire 8872 ECO, or Zurn Z8701-9.
- E. ADA Insulation:
 1. ADA Insulation – ADA Fixtures:
 - a. White molded closed-cell vinyl, 3-piece set for drain tailpiece, P-trap, and waste arm to wall, and two 2-piece sets for the cold and hot water supply stops, and risers.
 - b. Manufacturer: Insul-Tect I-T 101 and/or I-T 102, McGuire PW2125 and/or PW2150, Plumberex Handy-Shield MaXX, Pro Flo PF202WH, or Truebro 102 E-Z.
- F. Floor-mounted Carriers:
 1. For wall-hung lavatories: floor-mounted commercial type, with concealed arm supports.
 - a. Manufacturer: Josam, Smith, Wade, or Zurn.

2.3 URINALS AND TRIM

A. Fixtures:

1. F3A, Urinal - Wall Type, 0.125 GPF, Regular Use:
 - a. Vitreous china wall type with washout bowl, extended shields, flushing rim, top spud flush valve and trim for 0.125 gal per flush, and floor-mounted carrier.
 - b. Manufacturer: American Standard 6590.001, Kohler K-4904-ET, or Sloan SU-1009-A.
2. F3B, Urinal - Wall Type, 0.125 GPF, ADA Use:
 - a. Vitreous china wall type with washout bowl, extended shields, flushing rim, top spud flush valve and trim for 0.125 gal per flush, and floor-mounted carrier.
 - b. Manufacturer: American Standard 6590.001, Kohler K-4904-ET, or Sloan SU-1009-A.

B. Flush Valves:

1. Flush Valve – Sensor, Hard-wired, 0.125 GPF, Regular/ADA Use:
 - a. 0.125 gal per flush with sweat solder adapter kit, back check angle stop valve, vacuum breaker, hard-wired infrared sensor for automatic operation, and override button contained in a chromium-plated metal housing.
 - b. Manufacturer shall be same as urinal manufacturer: Sloan 186-0.125 ES-S, or Zurn ZEMS6003AV-ULF-IS.

C. Floor-mounted Carriers:

1. Carrier – Commercial Type:
 - a. For wall-hung urinals: dual post with cross bracing, floor-mounted pads, and hanger plates.
 - b. Manufacturer: Josam, Smith, Wade, or Zurn.

2.4 WATER FOUNTAINS AND TRIM

A. Fixtures:

1. F4A, Water Fountain – Wall Hung, Bi-Level, Refrigerated, Bottle Filler, Regular/ADA Use:
 - a. Wall hung electric water cooler, packaged as a single unit, with stainless steel panels, regular and barrier-free stainless steel tops, refrigeration unit, sensor activated bottle filling station with 1.0 gpm laminar flow located over the ADA unit, chrome plated bubbler heads with guards, self-closing push bar valves, supply with stop valve, P-traps, waste to wall, escutcheons, and mounting frame. Units shall be certified in accordance with NSF 61-2019.
 - b. Manufacturer: Elkay EZSTL8WSSK, Halsey Taylor HTHB-HAC8BLSS-ADA, or Oasis PG8EBFSL.

B. Supplies:

1. Angle stops with 0.5" sweat inlet, 0.375" od outlet, 0.375" od flexible tube riser, and wall escutcheon. Exposed piping and parts shall be chromium-plated.
2. Manufacturer: Just JVA22, Keeney 2048PCL12LF, or McGuire LF2165 ECO.

C. P-traps:

1. 1.25", 17 gauge tubular chromium-plated brass, with tubing drain to wall, wall flange, cast brass slip nuts, and cleanout plug.
2. Manufacturer: Just JT125, Keeney 5303PC866CR, McGuire 8872 ECO, or Zurn Z-8701-9.

2.5 SERVICE SINKS AND TRIM

A. Fixtures:

1. F5, Service Sink - Floor Type:

- a. Terrazzo neo-corner service sink, 24"x24"x12", with cast integral drain, 6" drop front with stainless steel rim guard over drop, wall hung faucet, hose with wall bracket, wall-mounted mop bracket, and stainless steel wall guard.
- b. Manufacturer: Fiat TSBC-1610, Florestone 96-24x24, or Stern-Williams SBC-1700.

B. Faucets:

1. Chromium-plated with hose thread outlet, pail hook, vacuum breaker, integral checks, stop valves in shanks, and wall support.
2. Manufacturer: Chicago 540-LD897SGCCP, T&S B-0665-BSTP, or Zurn Z843M1-XL-CS.

C. P-traps:

1. For floor type service sinks: 3" cast iron.
2. For wall-hung service sinks:
 - a. Deep seal, cast iron chemical resistant type, with grid strainer, and cleanout plug.
 - b. Manufacturer: Kohler K-6673, or Smith 9120.

D. Hose and Brackets:

1. 0.625" outside diameter x 36" long, heavy duty black hose with 0.75" coupling, and wall-mounted stainless steel hose bracket with spring loaded rubber grip.
2. Manufacturer: Fiat 832-AA, Florestone MR-370, or Stern-Williams T-35.

E. Mop Hangers:

1. 24" long stainless steel with 3 spring loaded rubber mop handle grips.
2. Manufacturer: Fiat 889-CC, Florestone MR-372, or Stern-Williams T-40.

F. Wall Guards:

1. Two 24" long x 12" wide, polished 20 gauge, type 304 stainless steel panels.
2. Manufacturer: Fiat MSG-2424, Florestone MR-377, or Stern-Williams BP.

2.6 COUNTER SINKS AND TRIM

A. Fixtures:

1. F6A, Sink - Stainless Steel, One Bowl, Regular Use:

- a. Self-rimming 18 gauge type 304 stainless steel sink, 19"x21"x7.5", one compartment with 3-hole punch, faucet, supplies with stop valves, drain, P-trap, waste to wall, and escutcheons.
- b. Manufacturer: Elkay LR-2219, or Just SL-1921-A-GR.

2. F6B, Sink - Stainless Steel, Two Bowls, Regular Use:

- a. Self-rimming 18 gauge type 304 stainless steel sink, 19"x33"x7.5", two compartment with 3-hole punch, faucet, supplies with stop valves, drains, continuous waste, P-trap, waste to wall, and escutcheons.
- b. Manufacturer: Elkay LR-3319, or Just DL-1933-A-GR.

3. F2C, Sink - Stainless Steel, One Bowl, ADA Use:

- a. Self-rimming 18 gauge type 304 stainless steel sink, 19"x21"x6", one compartment with 3-hole punch, faucet, supplies with stop valves, rear drain, P-trap, waste to wall, and escutcheons.
 - b. Manufacturer: Elkay LRAD-2219, or Just SL-ADA-1921-A-GR.
- B. Faucets:
 - 1. Faucet – Gooseneck Spout, Dual Lever, Regular/ADA Use:
 - a. Electronic type with polished chromium-plated brass body, self-adjusting battery type infrared sensor, vandal resistant gooseneck spout, base plate for 4" centers, and 1.5 gpm vandal resistant laminar flow control. Provide each faucet with an ASSE-1070 water mixing valve for nominal 109°F outlet temperature, cold and hot water inlets, integral checks, waterproof electronics with 10 sec wash cycle, a 2 sec maximum run-on time, batteries, and installation hardware. The assembly shall comply with ASME A112.18.1/CSA B125.1-2018 and ICC A117.1-2017.
 - b. Manufacturer: Chicago 116.203.AB.1/240.627.21.1/131-ABNF, Toto TEL5LG10, or Zurn Z6920-C-MV-CP4-XL.
- C. Supplies:
 - 1. Supplies – Angle Type, Wheel Handle:
 - a. Angle stops with 0.5" id x 5" inlet sweat tube, bell escutcheon, wheel handle control, 0.5" od x 12" flexible tube riser, and exposed piping and parts chromium-plated.
 - b. Manufacturer: Just JL27, Keeney 2780PCL12LF, or McGuire LF171 ECO.
- D. Strainers:
 - 1. Strainer - Grid Type:
 - a. Chromium-plated finish brass body and flat strainer with brass lock nut, sealant washers, and 1.5" x 4" seamless 20 gauge tailpiece.
 - b. Manufacturer: Elkay LK18, Just JSF8W, Keeney 1376PC, McGuire 152 ECO, or Zurn Z8739-PC.
- E. P-traps:
 - 1. P-trap – 1.5":
 - a. 1.5", tubular chromium-plated brass, with 17 gauge tubing drain to wall, wall flange, cast brass slip nuts, cleanout plug, and minimum 2" water seal.
 - b. Manufacturer: McGuire 8912CNC ECO, or Zurn Z8702-9LC-B.
- F. Continuous Waste:
 - 1. Continuous Waste – 1.5":
 - a. Continuous waste for multiple bowl counter sinks: chromium-plated 1.5", 17 gauge tubing.
 - b. Manufacturer: Just JWCH150, Keeney 1569SN, McGuire 113CG17 series, or Zurn Z8750 series.
- G. ADA Insulation:
 - 1. ADA Insulation – Waste and Supplies:
 - a. Insulation kit for ADA locations: white molded closed-cell vinyl, 3-piece set for tailpiece, P-trap, and waste arm, and two 2-piece sets for supply stops, and risers.
 - b. Manufacturer: Insul-Tect I-T 101 and/or I-T 102, McGuire PW2125 and/or PW2150, Plumberex Handy-Shield MaXX, Pro Flo PF202WH, or Truebro 102E-Z.

2. Dishwasher Connections – 1.5" Sink Tailpiece:
 - a. Tailpiece with dishwasher inlet branch: 1.5", 17 gauge tubular chromium-plated brass with 0.75" sweat connection and cast brass slip nut.
 - b. Manufacturer: CS&B 4855-8, Dearborn Brass 814B-17, Keeney 47SN, or Zurn R-7591.

2.7 SHOWERS AND TRIM

A. Showers – Regular Use:

1. F7A, Shower – Pressure-balanced, Lever Handle, 1.5 GPM Flow, Regular Use:
 - a. Pressure-balanced type 3-port mixing valve with adjustable temperature limit stop, check stops, hot and cold-color coded escutcheon, metal lever handle, adjustable brass shower head with 1.5 gpm flow control, shower arm and escutcheon. Exposed parts and accessories shall be chromium-plated.
 - b. Manufacturer: Speakman SM-3000 with 2253-E15, or Symmons 96-1-213-1.5-X-L.
2. Shower Basin – Precast Terrazzo, Regular Use:
 - a. Shower basin: 36" wide x 36" deep of precast terrazzo. Furnish unit with flanges on 4 sides for tile surrounds and thresholds, and integral cast drain with removable stainless steel grate.
 - b. Manufacturer: Fiat Sierra FT series, or Stern-Williams Sussex Square series.

B. Showers – ADA Use:

1. F7B, Shower – Pressure-balanced, Lever Handle, 1.5 GPM Flow, ADA Use:
 - a. Pressure-balanced type 3-port mixing valve with adjustable temperature limit stop, check stops, hot and cold color-coded escutcheon, metal lever handle, 30" adjustable slide bar, hand held shower head with 1.5 gpm flow control, 60" long metal hose, wall flange, inline vacuum breaker and swivel connector. Exposed metallic parts and accessories shall be chromium-plated.
 - b. Manufacturer: Leonard 4500 with 515P(G)-30, Powers P910H-L-W, or Symmons 96-300-B30-1.5-X-L-V.
2. Shower Basin – Roll-in Type, Precast Terrazzo, ADA Use:
 - a. Roll-in type: 60" wide x 36" deep of precast terrazzo meeting ADA guidelines. Furnish units with flanges on 3 sides for tile surround, built-in ramp with stainless steel cap, and integral cast drain with removable stainless steel grate.
 - b. Manufacturer: Fiat ADAW6036, or Stern-Williams WDA-3620 Parian.

2.8 WASHER CONNECTION BOXES

A. Fixtures:

1. Washing Machine Connection Box - Plastic:
 - a. Recessed wall-mounted washer box and faceplate, constructed of high impact polystyrene, with heavy duty mounting straps, knock outs for various supply routings, adjustable faceplate, 2" drain outlet, and cold and hot water hose valves with 0.5" brass sweat inlet connections, and 0.75" hose thread outlet connections.
 - b. Manufacturer: IPS 82064, or Oatey 38630.

2.9 ICE MAKER CONNECTION BOXES

A. Fixtures:

1. Refrigerator Ice Maker Connection Box - Plastic:
 - a. Recessed wall-mounted high impact polystyrene box and faceplate, with heavy duty mounting straps, adjustable faceplate, and brass cold water valve with 0.5" sweat inlet and 0.25" compression outlet.
 - b. Manufacturer: IPS AB9700, or Oatey 39156.

PART 3 - EXECUTION

3.1 PLUMBING FIXTURES AND TRIM - GENERAL

A. Fixtures:

1. Set fixtures level and in alignment with walls.
2. Caulk between fixtures and mounting surfaces with a white non-hardening mildew-resistant silicone sealant.
3. Install ADA fixtures in accordance with ICC A117.1-2017.
4. Reinforce the wall behind wall-hung fixtures with a galvanized steel plate bolted through the wall and sized for the fixture being installed, unless specified with floor-mounted carrier. Where back-plates are not possible, use minimum 0.375" diameter expansion or toggle bolts.

B. Trim:

1. Bolt chair carrier feet to the floor slab using all holes provided by the manufacturer. Carriers shall not depend upon wall construction or piping to prevent fixture movement.
2. Wrist blade handles on faucet fittings shall be aligned perpendicular to the spout when in the off position.
3. Faucets, shower valves, or flush valves used by ADA persons shall operate with less than a 5 psi operating force.
4. Set P-traps true and level. Tighten and secure all joints.
5. Locate transformers for hard-wired sensor flush valves and faucets as indicated on the Drawings. Provide all low voltage wiring in accordance with code, and coordinate for electrical power connections.

3.2 PLUMBING FIXTURES AND TRIM

A. Water Closets and Trim - (Series F1):

1. Fixtures:
 - a. Connect floor outlet water closets with cast iron floor flanges. Make the joint between the closet outlet and the floor flange with a gasket.
 - b. Caulk cast iron closet connectors to the cast iron closet bend or straight closet connection.
2. Trim:
 - a. Install flush valves for ADA water closets with the manual override on the wide side of the toilet stall.
 - b. Where automatic sensor flush valves are installed, coordinate the distance from the bottom of the ADA grab bar and the highest portion of the flush valve to allow for cap removal and battery replacement.
 - c. Wrench tighten flush valve stop cover to limit vandalism.

B. Lavatories and Trim - (Series F2):

1. Fixtures:

- a. For counter top installed lavatories, coordinate with counter top supplier for size of basin opening.
 - b. For under-mount lavatories, coordinate with counter top supplier for size of basin opening.
 - 2. Trim:
 - a. Set the flow period for adjustable metering faucets at 15 seconds.
 - b. For under-mount lavatories, coordinate with counter top supplier for faucet holes. Coordinate for the faucet to be as close as possible to the basin, for best overhang and use of water spout.
 - C. Water Fountains and Trim - (Series F4):
 - 1. Fixtures:
 - a. Anchor the bottom of wall-hung water fountains to the wall.
 - 2. Trim:
 - a. Install stop valves for water fountains within the water fountain cabinet.
 - b. For electric water coolers, insulate the P-trap and waste to wall.
 - D. Service Sinks and Trim - (Series F5):
 - 1. Trim:
 - a. Rough-in faucets for floor mounted service sinks at 30" above the floor.
 - b. Install wall hung mop hanger on adjacent wall to faucet, centered with fixture, and with bottom at 48" above the floor.
 - E. Counter Sinks and Trim - (Series F6):
 - 1. Fixtures:
 - a. For sinks installed in counter, coordinate with counter top supplier for size of opening.
 - b. For under-mount sinks, coordinate with counter top supplier for basin opening.
 - 2. Trim:
 - a. For under-mount sinks, coordinate with counter top supplier for faucet holes. Coordinate for the faucet to be as close as possible to the basin, for best overhang and use of water spout.
 - F. Showers and Trim - (Series F7):
 - 1. Fixtures:
 - a. Field set the adjustable temperature limit stop for pressure-balanced shower valves to allow a maximum of 110°F hot water to pass through the valve at full hot.
 - b. Factory set the adjustable temperature limit stop for combination thermostatic/pressure-balanced shower valves to allow a maximum of 110°F hot water to pass through the valve at full hot.
- 3.3 PLUMBING RELATED FIXTURES AND EQUIPMENT
- A. General:
 - 1. Plumbing related fixtures and equipment are: fixtures and equipment as provided by others that require water and drainage connections to the building plumbing systems.
 - 2. After plumbing related fixtures and equipment have been installed, provide piping and accessories as specified herein, and make final connections.
 - 3. The location and number of connections shown on the Drawings is approximate. Determine the exact number, location, and rough-in requirements from the equipment drawings and specifications.

B. Fixtures:

1. Provide rough-in for plumbing related fixtures.
2. For the water supply provide stops (or valves), supplies, and escutcheons, and faucets as required.
3. Provide pressure rated vacuum breakers for fixture trim having hose connection capabilities and no backflow prevention.
4. For drainage provide drains, tailpieces, P-traps, continuous waste, and escutcheons as required.
5. For exposed drainage piping that is not chromium-plated, prime and paint silver.

C. Equipment:

1. For pressure piping, rough-in each utility at 6" from wall or 6" above floor, unless otherwise indicated on the Drawings or required differently by the Equipment Manufacturer, with a valve and cap.
2. Provide vacuum breakers for connections requiring water, and not having built-in backflow prevention.
3. Provide indirect drains with waste connections, and extend over the appropriate floor sink and turn down with an indirect connection.

3.4 FIXTURE TESTS

- A. Test plumbing fixtures for soundness, stability of support, and operation.
- B. Test fixture accessories for smooth operation of handles and hand wheels, and proper operation of flow.
- C. Test flush valves for stability at the wall with no movement.
- D. Test the hot water temperature at each plumbing fixture, and ensure that the correct temperature water is flowing from the system.
- E. Flow all faucets and operate all flush valves until clear water is continuously observed.

3.5 WATERPROOF LINERS

- A. Where waterproof liners are used with the building construction, secure to the plumbing drain body with the clamping ring, making a watertight connection.
- B. Waterproof liners shall be specifically designed for shower pan construction.
- C. Install liners in accordance with the manufacturer's installation instructions.

3.6 CLEANING

- A. Clean plumbing fixtures and trim, and plumbing related fixtures, trim, and equipment, with a commercial grade disinfectant cleaner that will not damage the fixtures, trim, or equipment.
- B. Open and clean all faucet /strainers, and flush valve diaphragms/pistons of start-up film and construction debris.

END OF SECTION 224200

SECTION 224300 – DRAINAGE SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other plumbing systems are specified in other Sections of Division 22.
- B. Refer to Section 220010, Plumbing General, for a list of plumbing Sections included in this specification.
- C. This Section covers plumbing drainage, waste and vent systems.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. ICC A117.1-2017.
 - 2. North Carolina State Plumbing Code-2018.
- B. Specialty piping joint certification: installers shall be certified by the manufacturer of the piping joint system, prior to any installation.

PART 2 - PRODUCTS

2.1 PIPING, FITTINGS, AND JOINTS

- A. General:
 - 1. Piping and fitting sizes listed are nominal inside diameter.
- B. Soil, waste, vent, and rainwater 15" and smaller, below slab-on-grade and extending to 5' outside:
 - 1. Piping: hub and spigot cast iron, service weight, petroleum asphaltic-coated inside and out, ASTM A74-2017.
 - 2. Fittings: hub and spigot cast iron, service weight, petroleum asphaltic-coated inside and out, ASTM A74-2017.
 - 3. Joints: one-piece elastomeric compression gasket, ASTM C564-2014.
- C. Soil, waste, vent, rainwater, and secondary rainwater 10" and smaller, above slab-on-grade throughout the building:
 - 1. Piping: no-hub cast iron, petroleum asphaltic-coated inside and out, ASTM A888-2018a.
 - 2. Fittings: no-hub cast iron, petroleum asphaltic-coated inside and out, ASTM A888-2018a.
 - 3. Joints:
 - a. Medium duty stainless steel couplings for drainage and vent piping 1.5" to 8": mechanical compression type with neoprene collars conforming to ASTM C564-2014, type 304 stainless steel construction with shields (minimum 34 ga), bands, clamps, and screws. Couplings shall conform to FM 1680-1989, Class 1 for 80 lbf·in torque and a minimum pressure test of 15 psig.
 - 1) Manufacturer: Husky 2000, or Tyler WB.
- D. Concealed fixture drain connections from lavatories, water fountains, and counter sinks to cast iron:

1. Piping: copper tubing, type DWV, hard drawn, ASTM B306-2013.
2. Fittings: drainage pattern DWV wrought copper, ASME B16.29-2017.
3. Joints: soldered with 95/5 tin/silver using a compatible flux, ASTM B813-2016 and NSF 61-2019.

E. Fixture drain connections from urinals:

1. Piping: polyvinyl chloride (PVC) DWV, ASTM D2665-2014.
2. Fittings: drainage pattern DWV PVC, ASTM D2665-2014.
3. Joints: solvent cement, ASTM D2564-2012(2018).

F. Indirect drain, 1" and smaller:

1. Piping: copper tubing, type M, hard drawn, ASTM B306-2013.
2. Fittings: wrought copper, ASME B16.22-2017.
3. Joints: soldered with 95/5 tin/silver using a compatible flux, ASTM B813-2016 and NSF 61-2019.

G. Indirect drain, 1.25" and larger:

1. Piping: copper tubing, type DWV, hard drawn, ASTM B306-2013.
2. Fittings: drainage pattern DWV, ASME B16.29-2017.
3. Joints: soldered with 95/5 tin/silver using a compatible flux, ASTM B813-2016 and NSF 61-2019.

H. Pumped discharge from elevator sump pumps:

1. Piping: copper tubing type L, hard drawn, ASTM B88-2016.
2. Fittings: wrought copper, ASME B16.22-2018.
3. Joints: soldered with 95/5 tin/silver using a compatible flux, ASTM B813-2016.
4. Fittings: wrought copper press fittings, ASME B16.22-2018 with EPDM elastomeric O-ring seals, may be used at the Contractor's option for sizes 0.5" to 2".
 - a. Manufacturer: NIBCO Press, or ProPress.
5. Joints: pressed type, using the tools and pressure requirements of the fitting manufacturer.

2.2 SPECIALTY PIPING JOINTS

A. Unions:

1. For copper piping 2" and smaller: cast bronze or cast copper with copper soldered or threaded connections.
2. For piping of dissimilar metals 2" and smaller: provide dielectric unions with solder or threaded connections, nylon insulators, minimum 600 V no flashover, and EPDM gaskets.

B. Flanges:

1. For piping 2.5" and larger: flange and gasket type. Flanges shall match connection flanges in style, material, and pressure rating.
2. For piping of dissimilar metals 2.5" and larger: provide dielectric flanges with solder or threaded pipe connections, EPDM gaskets. Flanges shall match connection flanges in style, material, and pressure rating.

2.3 P-TRAPS

- A. For floor drains, and floor sinks: provide with trap primer connection in tail piece if not provided on drain body.
- B. Exposed: provide with cleanout plugs.

- C. For plumbing fixtures: as specified in Section 224200, Plumbing Fixtures.
- D. Elastomeric Trap Seals:
 - 1. Provide inside drains where indicated within the specifications and/or drawings.
 - 2. Flexible elastomeric, trap seal, protection device which allows wastewater to adequately discharge through the drain. The device shall open by incoming waste water and close, returning to its original shape, following the waste water discharge, the unit shall comply with ASSE 1072-2007.
 - 3. Manufacturer: Smith, SureSeal or Pro Vent Systems.

2.4 CLEANOUTS

- A. General:
 - 1. Provide cleanout outlets as follows:
 - a. Floors above grade: no-hub, push-on or inside caulk.
 - b. Floors on grade: push-on or inside caulk.
- B. Exterior piping: cast iron with adjustable housing, ABS cleanout plug, and round heavy duty scoriated cast iron tractor top, with "C.O." cast in and securing screws.
 - 1. Manufacturer: Josam 56040, Smith 4245, Wade 6000-Z, or Zurn Z-1400-HD-IC.
- C. Finished area floors: for piping 2" through 6", cast iron with internal cleanout plug, adjustable housing, and round polished bronze top with securing screws. For cleanouts in floors above grade, provide with flashing clamp.
 - 1. Manufacturer: Josam 55000-I, Smith 4025, Wade 6000IC, or Zurn ZN-1400-ZN-IC.
- D. Finished area floors: for piping 8" and larger, cast iron with internal cleanout plug, adjustable housing, and round polished bronze top with securing screws. For cleanouts in floors above grade, provide with flashing clamp.
 - 1. Manufacturer: Josam 56000-22-Y, Smith 4033, or Zurn ZN-1400-NL-BP.
- E. Mechanical room floors: cast iron with internal cleanout plug, adjustable housing, and nickel-bronze top. For cleanouts in floors above grade, provide with flange.
 - 1. Manufacturer: Josam 56040, Smith 4105, Wade 6000IC-Z-1, or Zurn ZN-1400-HD-IC.
- F. Wall construction: no-hub cleanout tee and tapped bronze cleanout plug, with a stainless steel wall access cover.
 - 1. Manufacturer: Josam 58600-COT, Smith 4532-Y, Wade 8560E+8480R, or Zurn Z-1446-BP-NH.

2.5 DRAINS

- A. General:
 - 1. Outlets shall be same size as the drainage pipe.
 - 2. Drains shall be from the same manufacturer, unless otherwise indicated.
 - 3. Provide drain outlets as follows:
 - a. Drains in roofs and floors above grade: no-hub, push-on, or inside caulk.
 - b. Drains in floors on grade: push-on, or inside caulk.
 - c. Specialty drains, where specified herein, in roof and floors: threaded.

B. Finished Area Drains (Series D1):

1. D1A: cast iron body, trimmed with adjustable 6" square nickel-bronze hinged grate with vandal resistant screws, sediment bucket, trap primer connection, and reversible flashing collar.
 - a. Manufacturer: Josam 30000X-S, Smith 2010B, Wade 1100 G, or Zurn ZN415-S.

C. Mechanical Room Drains (Series D2):

1. D2A: cast iron body, trimmed with recessed grate and 1" anti-splash rim, 7" round rough bronze grate, trap primer connection, and flashing clamp.
 - a. Manufacturer: Josam 30000X-7E1, Smith 2010-F37, Wade 1100 ER7-CI, or Zurn Z415-7I.
2. D2B: cast iron body, trimmed with 12" square rim, nickel-bronze secured half grate, 10" deep chemical resistant coated interior, dome bottom strainer, flashing clamp, and anchor flange.
 - a. Manufacturer: Josam 49060AS, Smith 3160, Wade 9150, or Zurn ZN-1902-K.

D. Roof Drains (Series D3):

1. D3A: cast iron body, trimmed with 11" round aluminum dome, combined flashing clamp and gravel stop, solid insulation extension, sump receiver, and under deck clamp.
 - a. Manufacturer: Josam 21500X, Smith 1010, Wade 3000, or Zurn Z100.
2. D3B: cast iron body, trimmed with 11" round aluminum dome, combined flashing clamp and gravel stop, solid insulation extension, 2" high interior standpipe, sump receiver, and under deck clamp.
 - a. Manufacturer: Josam 26010X, Smith 1070, Wade 3000-DFS, or Zurn Z100-W-2.

2.6 PUMPS

A. General:

1. Provide insulated cabling and final connections from the control panel to the pump motors, level controls, and alarms.

B. Small Capacity Sump Pumps:

1. General: submersible type for a simplex installation with controls, wiring, piping, and valves.
2. Controls: UL labeled single pole on/off float switch tethered to the motor.
3. Controls: UL labeled NEMA 1 fiberglass control panel with power on and pump running lights, high water and overload lights and alarms with alarm silence, pump selector switches, and automatic pump alternator. Provide pressure diaphragm actuated micro-switch level controls (for pump on, pump off, and high liquid level alarm) with cable wiring to control panel. Provide contactors for the building control system to signal pumps at standby, pumps running, and pump failure.
4. Motors: submersible hermetically sealed with class F insulation for maximum 3500 rpm. Motors shall be direct connected to pumps, supplied with a minimum 20' power cord, have built-in thermal and overload protection with automatic reset, and rated for continuous duty submerged.
5. Pumps: close-couple design with cast iron body, solid stainless steel shaft, cast iron impeller, mechanical seals, and permanently lubricated ball bearings with a minimum 14,200 hr bearing life. The pump shall be non-overloading at any point on the pump curve, and shall be statically and dynamically balanced.
6. Warranty: provide the pump, controls, and equipment with a manufacturer's written one year warranty.
7. Manufacturer: Ebara, Hydromatic, Myers, Stancor, Weil, or Zoeller.

C. Large Capacity Sump Pumps:

1. General: submersible type for a simplex installation with controls, wiring, piping, and valves.
2. Controls: UL labeled NEMA 1 fiberglass control panel with power on and pump running lights, high water and overload lights, and alarms with alarm silence , pump selector switches, automatic pump alternator, and non-resetting run-time meters. Provide pressure diaphragm actuated micro-switch level controls (for pump on, pump off, and high liquid level alarm) with cable wiring to control panel. The level controls shall be designed for complete removal through the basin cover. Provide contactors for connection with the building control system to signal pumps at standby, pumps running, and pump failure.
3. Motors: submersible hermetically sealed with class F insulation for 3000 rpm. Motors shall be direct connected to pumps and supplied with a minimum 20' power cables, have built-in thermal and overload protection with automatic reset, and rated for continuous duty submerged.
4. Pumps: close-couple non-clogging design with cast iron body, solid stainless steel shaft, cast iron impeller, double mechanical seals, permanently lubricated ball bearings with a minimum 14,200 hr bearing life, and casing inlet protection. The pump shall be non-overloading at any point on the pump curve, be statically and dynamically balanced, and able to pass minimum 2" diameter solids.
5. Removal system: compatible with the pump being installed, and consisting of a base elbow, and pump to elbow sliding bracket. Additionally, provide a stainless steel guide pipe (as sized by the pump manufacturer), retrieval cable and cable tie-off.
6. Warranty: provide the pump, controls, and equipment with a manufacturer's written three year warranty.
7. Manufacturer: Ebara, Hydromatic, Myers, Weil, or Zoeller.

2.7 LINT INTERCEPTORS

- A. Steel construction with epoxy coating interior and exterior, and no-hub inlet and outlet. Provide units with primary and secondary removable stainless steel lint screens, skid resistant secured and gasketed cover, extension to finished floor, flashing flange and clamp, and vent connection.
- B. Provide interceptors to be direct buried in the earth.
- C. Provide interceptors with 20 gpm flow capacity.
- D. Manufacturer: Josam 61800 series, Smith 8910 series, Wade 5600 series, or Zurn Z-1185 series.

2.8 ACCESSORIES

- A. Bolts and nuts: ASTM A307-2014e1, Grade B.
- B. Downspout covers: fabricated stainless steel flange with secured hinged perforated grate, and vandal resistant screws.
 1. Manufacturer: Smith 1775, Wade 3950-SS, or Zurn Z-199-DC.
- C. Stack sleeves: coated cast iron stack sleeve, with caulking recess, flashing flange, nonpuncturing flashing clamp ring, pressure ring, and under deck clamp.
 1. Manufacturer: Josam 26450, Smith 1720, Wade 3630, or Zurn Z-195.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. General:

1. Piping shall be cut to measurements established at the site and worked into place without springing or forcing.
2. Make changes in the horizontal direction of gravity drainage piping with drainage pattern fittings.
3. Use concentric reducing fittings between different size pipe.
4. Ream steel, and copper pipe after cutting, turn on end and knock loose dirt, scale, and filings from interior of pipe.
5. Install horizontal drainage piping 3" and smaller with a slope of 0.25" per foot, and piping 4" and larger with a slope of 0.125" per foot unless otherwise noted on the Drawings.
6. Pitch/grade: piping shall be installed with sufficient pitch to ensure drainage and venting.
7. Install sway bracing and anchorage for piping as required by International Plumbing Code-2018.

B. Underground Piping:

1. Install drainage piping outside the building in trenches separate from water piping.
2. Excavation and backfill: as specified in Section 220010, Plumbing General.
3. Underground piping shall be connected to the exterior service lines, or capped or plugged if the exterior service is not in place.
4. Piping installed below the level of footings shall be installed 12" horizontally from the footing for each 12" of depth below the footing.

C. Piping Joints:

1. Solder joint connections shall be cut, deburred, cleaned and assembled in accordance with ASTM B828-2016.
2. Threaded connections: screw-thread joints shall be made with cut tapered threads. Joints shall be made tight with Teflon tape. Not more than 2 threads shall show after the joint is made tight, except no threads shall show in exposed chromium-plated piping.
3. Flanged joints: at connections to equipment, flanged joints shall be made with ring type gaskets, extending to inside of bolt holes. Flanged connections to equipment shall be made with full-face gaskets to match flanges on equipment.
4. Mechanical couplings on drainage piping: during the torque process, if any one band of the coupling breaks, replace the entire coupling.
5. Isolate joints between dissimilar metals and connections to tanks with dielectric fittings.
6. Provide adapters where copper or steel pipes connect to cast iron pipe.
7. Provide adapters where cast iron pipe connects to plastic, ductile iron, concrete, or clay pipe, or where field cuts are made in vitrified earthenware or concrete piping. Adapters shall be sized to fit into the bell of pipes with hubs, or over the barrel of pipes without hubs.

D. Coordination:

1. Pipes shall be installed to permit free expansion and contraction without damage to joints, hangers, or the building. Arrange piping to minimize stresses caused by expansion and contraction.
2. Install piping so as to preserve access to valves and equipment and to provide the maximum headroom possible.
3. Provide offsets as required to maintain ceiling height and to coordinate with other trades.
4. Install exposed piping such that when insulation is applied it will not come in contact with adjacent surfaces.
5. Provide flanges or unions at connections to valves and apparatus.

6. Piping to fixtures and equipment shall be braced so that there is no horizontal or vertical movement in the piping.
7. Pipe supports shall be isolated from copper tubing with rubber sleeves.
8. Install food service piping above slab-on-grade in a manner to allow for rapid changes in temperature.
9. Where piping is running parallel to bar joint construction, and there is more than one pipe to be attached to bottom cord of joint, provide supplement steel supports spaced at the minimum hanger spacing, and tac-welded to joint.

3.2 PIPING, FITTINGS, AND JOINTS

A. Hub and Spigot Cast Iron Pipe and Fittings:

1. Do not use tee fittings in horizontal drainage piping.
2. Install with hubs upstream.
3. Joints and fittings shall be made with compression type gaskets.

B. No-Hub Cast Iron Pipe and Fittings:

1. Do not use tee fittings in horizontal drainage piping.
2. Extend vent piping 12" above the roof.
3. Torque coupling bolts in accordance with manufacturer's recommendations.
4. Where extra heavy duty couplings are required for underground connections, coat the stainless steel bolts with asphaltic paint sealer.
5. Install pull-out restraints on no-hub sanitary and waste drainage, and rainwater piping and fittings 5" and larger, at changes in direction and changes in pipe size greater than 2 pipe diameters, in accordance with the International Plumbing Code-2018. Provide the restraints with a minimum of 50' of thrust resistance.

C. Copper Tubing and Fittings:

1. Uninsulated piping installed in masonry construction shall be painted with 2 coats of asphaltum paint.
2. Clean, prime, and paint exposed uninsulated piping with 2 coats of glossy silver paint.

3.3 SPECIALTY PIPING JOINTS

A. Unions

1. Provide in each connection to each piece of equipment, where equipment may be removed.

B. Flanges

1. Provide in piping connections to equipment where flanges are present.

3.4 P-TRAPS

A. Set traps true and level.

B. Provide in rainwater piping connecting to combination sewers.

C. Install elastomeric trap seals in accordance with manufacturer's instructions.

3.5 CLEANOUTS

A. General:

1. Locate cleanouts so that they are accessible and in compliance with codes.
 2. Install floor cleanouts flush and level with the finished floor.
- B. Provide cleanouts in drainage piping as indicated on the Drawings, and as follows:
1. At the bottom of each exposed fixture trap which is not integral with the fixture.
 2. At the beginning of each branch drainage line.
 3. At each change of a horizontal direction greater than 45°.
 4. At the foot of each stack.
 5. In horizontal drain lines at intervals of not more than 50' for inside piping and 100' for outside piping.
- C. Cleanouts outside the building shall extend up to grade and be set flush with finished grade in a 18" x 18" x 8" thick concrete pad.
- D. Cleanouts for horizontal piping above grade located above the ceiling shall extend through the floor above, and shall be set flush with that finished floor.
- E. Sanitary cleanouts shall not be installed in return air plenums.
- F. Cleanouts that occur in carpeted floors shall be installed flush with the floor slab and marked with a stainless steel carpet marker.

3.6 DRAINS

- A. General:
1. Cover the grate of each drain during construction to prevent entry of foreign matter. The covering shall not deface the grate's finish.
 2. Remove and clean drain grate, set-screws, insides of drain bodies, and sediment buckets before date of the Architect's final certificate.
 3. Drains shall not be field modified, except grates may be modified where required for above floor indirect drainage piping.
 4. Where waterproof liners are used in the building construction, secure the liners to drain bodies with clamping rings, making watertight connections.
 5. Provide trap seal protection for each drain, except shower drains and equipment/fixture drains.
- B. Floor Drains/Floor Sinks:
1. Set top of floor drains and floor sinks flush and level with the finished floor, unless noted otherwise on the Drawings.
 2. Install drains with recessed grates and anti-splash rims, with the rims flush with the finished floor.
 3. Omit grates of drains receiving piped discharge from mechanical equipment so pipes can turn down into basket, unless provided otherwise.
 4. Where trap primer connections are made to drain tailpieces, cap or eliminate the trap primer connection on the drain body.
 5. Set square drainage grates with sides parallel to the adjacent walls.
 6. Where drains are installed in a sloping floor, install at low point.
- C. Roof Drains:
1. Provide for each roof drain a sheet of 4 psf lead flashing extending at least 8" from the clamping ring in all directions, for built-up roofing.
 2. The horizontal portion of scupper drains shall pitch down in the direction of flow not less than 0.25" per foot.
 3. For PVC roofing, flash the PVC material a maximum of 1" into the drain body past the drain clamp.

3.7 PUMPS

- A. For submerged sump pumps with removal rail system, mount the base elbow securely to the pit floor using the maximum bolt sizes recommended by the manufacturer.
- B. Install a ball check valve immediately on the discharge pipe of each grinder sewage pump.
- C. Coordinate final sump basin sizes for proper fit of pump and motor to be installed, and installation of accessories.
- D. Make the sump pump basin frame and top cover gastight with a bitumastic caulking or factory supplied gaskets. Make access panels in the top cover gastight with factory supplied gaskets.
- E. Make pipe and wiring conduit penetrations through the basin cover gastight with compression rings and sealant compound, using compression flanges.
- F. Install exterior basins with top at 6" above the finished grade.
- G. Sump pumps shall not be used for dewatering. If pumps are used in an emergency, replace with new units.

3.8 ACCESSORIES

- A. Downspout boots: set top 12" above finished grade, unless noted otherwise.
- B. Coordinate the size of architectural downspouts with size of downspout boot's top connection.

3.9 ROOF PENETRATIONS

- A. Vents Through Roofs:
 - 1. Flat roofs with plastic membrane roofing: flashed and sealed water tight by the membrane installer.
- B. Piping Through Roofs:
 - 1. Flat roof stack sleeves: where single pipes pass through the roof, flash the stack sleeve with a sheet of 4 psf lead flashing extending at least 8" from the clamping ring in all directions under the roofing material.
 - 2. Provide a waterproofed caulked joint in the top hub of the stack sleeve around the installed pipe after final installation.
- C. Roof Drains:
 - 1. Plastic membrane roofs: flashed and sealed watertight by the membrane installer. Ensure the membrane opening inside the drain is cut large enough to allow for proper water flow and roof drainage.

3.10 PIPING AND JOINTS TESTS

- A. Piping and piping joints shall be leak free.
- B. Test soil, waste, vent, and rainwater, systems piping and joints in sections by capping or plugging all openings, and filling each system with a 10' head of water, then allowing to stand filled for 1 hour without any leak down.

C. General:

1. Test piping and joints under floor slabs before slabs are poured.
2. Tests shall be made while piping and joints are exposed to view.
3. Submit a statement certifying that piping and joints are tight and have passed the specified test.

D. Leakage Requirements:

1. Screwed and flanged joints that leak shall be taken apart and reassembled.
2. Soldered joints that leak shall be cut-out and replaced.
3. Cast iron hub and spigot joints that leak shall be taken apart and reassembled with new joining materials.
4. Cast iron no-hub joints that leak shall be taken apart and reassembled with new couplings.

E. Flow Test:

1. Ensure a smooth and nonobstructed flow of liquid for every drainage pipe, free from construction or natural sediment debris that may have entered during construction.
2. Route clean and flush with clear water piping having an obstruction.

3.11 SUMP PUMP TESTS

A. General: pump any liquid from sump. Do not use Project's new pumps. Clean sumps, pumps, and motors of construction debris.

B. Elevator Sump Pump Test:

1. Traction elevators: fill sump as required with potable water and test for pump on, high water alarm, and pump off. Pump shall perform at its rated capacity. Test check valve for complete stoppage at pump shut off. If pump or controls fail test, repair or replace units as necessary.
2. Hydraulic elevators: fill sump as required with potable water and test for pump on, high water alarm, and pump off. Pump shall perform at its rated capacity. Test check valve for complete stoppage at pump shutoff. Add hydraulic elevator oil to the water and test for pump off and oil alarm. Clean sump of oil residue. If pump or controls fail test, repair or replace units as necessary.

C. Safety alarm test: provide a test for the safety alarm as described by the manufacturer.

D. Provide written documentation of the pump operational test and safety alarm test.

END OF SECTION 224300

SECTION 224400 - WATER SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other plumbing systems are specified in other Sections of Division 22.
- B. Refer to Section 220010, Plumbing General, for a list of plumbing sections included in this specification.
- C. This Section covers plumbing water systems.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. North Carolina State Energy Conservation Code-2018.
 - 2. North Carolina State Plumbing Code-2018.
- B. Specialty piping joint certification: installers shall be certified by the manufacturer of the piping joint system, prior to any installation.
- C. Wetted components in the potable water system, where the water is anticipated for human consumption, shall comply with the Reduction of Lead in Drinking Water Act-2011.

PART 2 - PRODUCTS

2.1 PIPING, FITTINGS, AND JOINTS

- A. General:
 - 1. Piping and fitting sizes listed are nominal inside diameter.
 - 2. For copper pipe applications, use mechanically crimped copper joint systems, OR use solder joints and flux that comply with ASTM B828 2016, and ASTM B813 2016, respectively.
 - 3. For water intended for human consumption:
 - a. Use pipes and pipe fittings that comply with California Law AB1953, which requires that the wetted surface area have a weighted average lead content of not more than 0.25%.
 - b. Solder and flux used to connect plumbing pipe on site shall meet California AB1953 standard, which specifies that solder not contain more than 0.2% lead, and flux not more than a weighted average of 0.25% lead for wetted surfaces.
- B. Cold water, hot water, and hot water circulating, underground, 2.5" and larger:
 - 1. Piping: copper tubing, type K, hard temper, ASTM B88-2016.
 - 2. Fittings: wrought copper, ASME B16.22-2018.
 - 3. Joints: brazed with brazing filler metal, BcuP-3, silver-phosphorous, AWS A5.8/A5.8M-2011.
- C. Cold water, hot water, hot water circulating, trap primer, and relief valve discharge, above grade, 0.5" to 2.5", except chromium-plated piping at fixtures:
 - 1. Piping: copper tubing, type L, hard temper, ASTM B88-2016.
 - 2. Fittings: wrought copper and/or cast bronze socket fittings, 0.5" to 2.5", ASME B16.22-2018.
 - 3. Fittings: wrought copper press fittings, ASME B16.22-2018 with EPDM elastomeric O-ring seals, may be used at the Contractor's option for sizes 0.5" to 2.5".

- a. Manufacturer: NIBCO Press Fittings, or Viega ProPress.
- 4. Joints:
 - a. Soldered with 95/5 tin/silver or tin/antimony alloy type, with a compatible flux designed to be cold water flushable in potable water systems, ASTM B813-2016 and NSF 61-2019.
 - b. Pressed type, using the tools and pressure requirements of the fitting manufacturer.
 - c. Cold water, and hot water, above grade, 3" to 8":
 - d. Piping: copper tubing, type L, hard temper, ASTM B88-2016.
- 5. Fittings:
 - a. For roll-grooved joints, 3" to 8": full flow standard radius, manufacturer supplied copper-tube dimensioned, roll-grooved of wrought copper, ASME B16.22-2018.
 - 1) Manufacturer: Anvil, Grinnell Mechanical Products, or Victaulic.
 - b. For brazed piping joints, 3" to 8": wrought copper and/or cast bronze socket fittings, ASME B16.22-2018.
- 6. Joints:
 - a. Brazed with brazing filler metal, BcuP-3, silver-phosphorous, AWS A5.8/A5.8M-2011.

2.2 SPECIALTY PIPING JOINTS

A. Unions:

- 1. For copper piping 2" and smaller: cast bronze with copper soldered connections.
- 2. For steel piping 2" and smaller: ground joint with brass-to-iron seat.
- 3. For piping of dissimilar metals 2" and smaller: provide dielectric unions with solder or threaded connections, nylon insulators, and minimum 600 V no flashover.
- 4. For press fit piping 2" and smaller: hexagonal threaded type with press fit ends.

B. Flanges:

- 1. For copper piping 2.5" and larger: class 150, cast bronze companion flange NSF 61-2019 lead free, with solder cup, and flat flange face. Provide a 0.125" thick EPDM NSF/ANSI 61 type rubber gasket.
- 2. For piping of dissimilar metals 2.5" and larger: provide dielectric flanges with solder or threaded pipe connections. Provide a 0.125" thick EPDM NSF/ANSI 61 type rubber gasket.
- 3. Flanges for equipment connections shall match the equipment's flange in style, material, and pressure rating. Provide a 0.125" thick EPDM NSF/ANSI 61 type rubber gasket.

2.3 VALVES

A. General:

- 1. Valves shall be of the same manufacturer, except where a specific product is not available.
- 2. Stem packing: asbestos-free.

B. Gate Valves:

- 1. Gate valves 3" and larger: class 250, iron body with bronze trim, outside screw and yoke, bolted bonnet, solid wedge, renewable seats, flanged ends, 500 psig wog, MSS SP-70-2011.
 - a. Manufacturer: Apollo 621F series, Hammond IR330, Milwaukee F-2894, or NIBCO F667-O.

C. Globe Valves:

1. Globe valves 2.5" and smaller: class 125, bronze body with threaded bonnet, integral seat, renewable bronze seat and disc, 200 psig wog.
 - a. Manufacturer (solder ends): Apollo 121S-LF, Hammond UP418, or Milwaukee UP1502.
 - b. Manufacturer (threaded ends): Apollo 121T-LF, Hammond UP440, or Milwaukee UP502.
2. Globe valves 3" and larger: class 250 iron body with bronze or stainless steel trim, outside screw and yoke, bolted bonnet, integral guide for proper alignment of seat to disc, renewable bronze disc and seat, flanged ends, 500 psig wog, MSS SP-85-2011.
 - a. Manufacturer: Apollo 721F, Hammond IR313, Milwaukee F-2983, or NIBCO F-768-B.

D. Ball Valves:

1. For copper piping, 2" and smaller: 2-piece bronze or bronze alloy body, full port, with blowout-proof stem, rated for 600 psig wog. Valves shall have a stainless steel ball, reinforced seat, stuffing box ring, memory stop, and lever handle. Valves in insulated piping shall have 1.25" extended stems.
 - a. Manufacturer (soldered ends): Apollo 77CLF-240, Hammond UP8313A, Milwaukee UPBA450S, or NIBCO S-585-66-LF.
 - b. Manufacturer (threaded ends): Apollo 77CLF-140, Hammond UP8303A, Milwaukee UPBA400S, or NIBCO T-585-66-LF.
2. For copper press fitting piping, 2" and smaller: 2-piece bronze or bronze alloy body, full port, with blowout-proof stem, rated for 200 psig wog. Valves shall have a stainless steel ball, reinforced TFE seat, stuffing box ring, grade E EPDM elastomeric O-ring seals, and press by press female ends. Valves in insulated piping shall have 1.25" extended stems.
 - a. Manufacturer: Apollo 77WLF-140 series, NIBCO PC585-66-LF, or Viega ProPress 2970.3ZL.

E. Butterfly Valves:

1. For flanged piping, 2" and larger: drilled and tapped lug type with ductile iron body, 316 stainless steel disc, EPDM seat designed for service at 200 psig and 200°F, stainless steel shaft, permanently lubricated bushings on each end of the shaft, and conforming to MSS SP-67-2017. Butterfly valves shall be factory hydrostatically tested at 150% of operating pressure, factory-tested bubble-tight at 150 psig disc differential, and shall be designed for dead-end service without a back-up flange. Operators shall be the lever and quadrant type for valves 2" and 3", and manual hand-wheel gear type for valves 4" and larger.
 - a. Manufacturer: Apollo 141 series, Hammond 6411 series, Milwaukee ML233E and ML333E, or NIBCO LD-2000.

F. Check Valves:

1. Check valves 2.5" and smaller: class 125, bronze body, Y-pattern horizontal swing with renewable bronze disc and seat, screw cap, 200 psig non-shock cwp.
 - a. Manufacturer (solder ends): Apollo 161S-LF, Milwaukee UP1509, or NIBCO S-413-Y-LF.
 - b. Manufacturer (threaded ends): Apollo 161T-LF, Milwaukee UP509, or NIBCO T-413-Y-LF.
2. Check valves 3" and larger: class 125, iron body, dual-disc wafer type with spring hinge, bronze disc, EPDM seat, 200 psig non-shock cwp.
 - a. Manufacturer: Apollo 910WB, Hammond IR9253, or NIBCO W-920-W-LF.

2.4 STRAINERS

- A. Strainers 2.5" and smaller: class 125, bronze body, Y-pattern, with a 20 mesh type 304 stainless steel screen, threaded cap, 200 psig non-shock cwp.
 - 1. Manufacturer (solder ends): Apollo 59LF-300, or Wilkins YBXLC.
 - 2. Manufacturer (threaded ends): Apollo 59LF-000, or Wilkins YBXL.
- B. Strainers 3" and larger: class 125, iron body, Y-pattern, with FDA coating inside and outside, type 304 stainless steel screen, bolted cap, with blow-off plug and valve, flange ends, 200 psig non-shock cwp.
 - 1. Manufacturer: Apollo 125-YF, Hammond 3030, or NIBCO F-721-A.

2.5 HOSE BIBS

- A. For mechanical or equipment spaces: chromium-plated brass with 0.75" inlet, tee handle, built-in atmospheric vacuum breaker, and 0.75" hose thread outlet.
 - 1. Manufacturer: Chicago 952 XKCP, T&S B-0722-RGH, or Zurn Z875L7.
- B. For finished areas: polished chromium-plated brass with 0.75" inlet, tee handle, built-in atmospheric vacuum breaker, and 0.75" hose thread outlet.
 - 1. Manufacturer: Chicago 952XK, T&S B-0722, or Zurn Z875L7.

2.6 HYDRANTS

- A. Wall Hydrants:
 - 1. Non-freeze type with bronze body and casing, 0.75" threaded inlet, 0.75" hose thread outlet, integral vacuum breaker, key handle, adjustable wall clamp, recessed box with hinged locking cover with the word WATER cast in, and polished bronze finish.
 - a. Manufacturer: Josam 71000, Smith 5509 QT, Wade 8600-175, or Zurn Z-1300.
- B. Roof Hydrants:
 - 1. Fully self-contained nonfreeze post type hydrant consisting of a brass wheel handle hose bib, 0.75" hose thread backflow preventer, riser post, integral stainless steel drain back canister with vent pipe for freeze protection, self-adjusting solid brass operating rod with replaceable O-ring seal, and 0.75" threaded brass inlet.
 - a. Manufacturer: Hoeptner 2131R, or Woodford SRH-MS.

2.7 PRESSURE REDUCING VALVES

- A. Direct operating type with low capacity, bronze body, stainless steel spring, sealed spring chamber, stainless steel seat ring, composition disc, built-in bypass, and threaded ends. Provide units with isolation valves, pressure gauges, and strainers.
 - 1. Manufacturer: Apollo PRCLF, or Wilkins 70XL.
- B. Direct operating type with high capacity, bronze body, stainless steel spring, sealed spring chamber, stainless steel seat ring, composition disc, built-in bypass, and threaded ends. Provide unit with isolation valves, pressure gauges, and separate wye pattern strainer.
 - 1. Manufacturer: Apollo PRLF, or Wilkins 500XL.

2.8 BACKFLOW PREVENTERS

- A. Reduced pressure type for cold water 0.75" to 2": with bronze body, stainless steel working parts, check modules, test cocks, relief module, and threaded ends. Provide the assembly with isolation valves, air gap drain device, and separate wye pattern strainer.
 - 1. Manufacturer: Apollo RP4ALF, or Wilkins 975XL.
- B. Reduced pressure type for hot water 0.75" to 2": with bronze body, stainless steel working parts, check modules, test cocks, relief module, threaded ends, and all parts designed for 140°F water service. Provide the assembly with isolation valves, air gap drain device, and separate wye pattern strainer.
 - 1. Manufacturer: Apollo RP4ALF, or Wilkins 975XL.
- C. Reduced pressure type for cold water 2.5" to 8": with type 304 stainless steel body inside and out, stainless steel working parts, check modules, test cocks, relief module, and grooved or flanged ends. Provide the assembly with FDA epoxy coated OS&Y isolation valves, air gap drain device, and separate wye pattern strainer.
 - 1. Manufacturer: Apollo RP4ALF, or Wilkins 375AST.
- D. Double check valve assembly type for cold water 0.75" to 2": with bronze body, stainless steel springs, guides, fasteners, corrosion resistant check modules, renewable seats, test cocks, and threaded ends. Provide the assembly with isolation valves and separate wye pattern strainer.
 - 1. Manufacturer: Apollo DC4ALF, or Wilkins 95XL.

2.9 VACUUM BREAKERS

- A. Pressure type, spill resistant for cold and hot water 0.5" to 1": with bronze body, check valve, replaceable valve seat, spring-loaded float disc, stainless steel springs, vent disc with isolation to the water stream, inlet/outlet isolation valves, and operating temperature to 180°F.
 - 1. Manufacturer: Apollo SVB4WLF, or Wilkins 460XL.

2.10 TRAP PRIMERS

- A. Brass construction, capacity to prime traps as indicated on the Drawings, line pressure operation.
 - 1. Manufacturer:
 - a. Trap primer for flush valve lines: Precision Plumbing Produces, Prime-Rite.
 - b. Trap primer for faucet lines: Precision Plumbing Products, Oregon 1 PO-500.
 - c. Distribution unit: Precision Plumbing Products, DU-4.
- B. Automatic trap primer panels: factory-assembled packaged trap primer manifold with atmospheric vacuum breaker, preset 24 hour timer set for 10 seconds (minimum) operation every 24 hours, manual override switch, 120 V solenoid valve, 0.75" inlet connection, 0.5" outlet compression fittings, water hammer arrester and enclosed in a 16 gauge steel cabinet with prime coated access door.
 - 1. Manufacturer: Precision Plumbing Products Prime-Time Manifold.
- C. Automatic mini trap primers: electronic trap primer with distribution unit, 1" air gap, preset 24 hour timer set for 10 second minimum operation every 24 hours, manual override switch, fuse, 120 V solenoid valve, 0.5" inlet connection, and 0.375" outlet compression fittings.
 - 1. Manufacturer: Precision Plumbing Products Mini-Prime, or Zurn Z-1020-ETP.

2.11 WATER HAMMER ARRESTERS

- A. Enclosed piston type with copper tubing enclosure, FDA approved double O-ring seals, threaded connections, ASSE 1010-2004 certified.
 - 1. Manufacturer: Precision Plumbing Products SC series, Sioux Chief 650 series, Smith 5200 series, Watts LF15M2 series, or Wilkins 1250XL.

2.12 PRESSURE GAUGES

- A. Bourdon tube type with stainless steel tube and socket, stainless steel movements with 0.5% accuracy over the full scale, and 150°F minimum operating temperature.
- B. The wetted parts shall be housed in a flangeless metal case with a clear safety glass lens, stainless steel front ring, and stainless steel 0.25" NPT lower connection. Provide each gauge with a stainless steel pressure snubber and needle valve 250 psig for piping connections.
- C. The dial face shall be white painted aluminum 4.5" in diameter with black graduations and letterings. The units of measure shall be in psig. The pointer shall be black painted aluminum and adjustable.
- D. Gauges shall be selected where the average pressure is at the scale's midpoint, and incorporating the following as applicable:

<u>Location</u>	<u>Scale Range</u>
Inlet of pressure reducing valves	0 to 200 psig.
Outlet of pressure reducing valves	0 to 100 psig.
Inlet of water pressure booster systems	0 to 200 psig.
Outlet of water pressure booster systems	0 to 300 psig.

- E. Fill liquid-filled gauges with food grade glycerin.
- F. Manufacturer:
 - 1. Filled case: Trerice 700 series, Weiss PFP series, Weksler HY44-8, or Winters PFP-SG4.

2.13 THERMOMETERS

- A. Blue- or green-reading organic-filled every-angle, industrial type with aluminum case, glass lens, 9" scale length, and accuracy rating of $\pm$ one scale division. Thermometers installed in insulated piping shall have 6" stems with brass thermowell, filled with heat transfer medium, and extension.
- B. Scale range: 30°F to 240°F.
- C. Manufacturer: Trerice BX9-SPB, Weiss A9VU, Weksler EG5L-9, or Winters 9IT.

2.14 WATER HEATERS

- A. Commercial electric water heater, 120 gallons and smaller, UL listed packaged unit with vertical storage tank, heating elements, ASME pressure and temperature relief valve, controls with enclosure, and meeting the mandatory provisions of ASHRAE/IES 90.1-2019 and ANSI Z21.10.3-2017/CSA 4.3-2017.
 - 1. Controls: upper and lower immersion thermostats, temperature adjustment control, high temperature shut-off, low water shut-off, and low watt density immersion heating elements with time sequencer configuration.

2. Tanks: cement- or glass-lined carbon steel, 125 150 psig working pressure, polypropylene or cross-link polymer dip tube, and drain valve. For tanks with porous linings provide a magnesium anode rod.
 3. Enclosures: minimum K value of 2.17 Btu·in/(h·ft²·°F) at 80°F for tank insulation, and steel jacket with baked enamel finish.
 4. Warranty: the complete water heater assembly shall be provided with a nonprorated warranty, in writing, by the manufacturer for a period of 1 year from heater start-up. The warranty shall include defects in the design and construction of the assembly, including parts and components. Additionally, there shall be a nonprorated 3 year warranty against tank failure due to rust, and an operational warranty for odor and discolored water due to tank rust or tank lining. The warranty shall cover all costs including parts, heaters, shipping, and labor, with no cost being incurred by the Owner. If repairs are unable to be performed, the water heater shall be replaced with an equal unit.
 5. Manufacturer: Bock, Bradford White, Hubbell, Lochinvar, Rheem/Ruud, A.O. Smith, or State.
- B. Commercial electric water heater, 125 gallons and larger, UL listed packaged unit with vertical storage tank, heating elements, ASME pressure and temperature relief valve, controls with enclosure, meeting the mandatory provisions of ASHRAE/IES 90.1-2019 and ANSI Z21.10.3-2017/CSA 4.3-2017.
1. Controls:
 - a. Upper and lower immersion thermostats, temperature adjustment control, high temperature shut-off, high and low pressure shut-off, low water shut-off, magnetic contactors, control circuit transformer, control circuit switch, fuse and pilot light, fuses for each power circuit, 7 day time switch, and safety door interlock.
 - b. Communications port to communicate with the building control system to monitor that the heater is on or off.
 2. Heating elements: immersion type, heavy duty, 80 W/in² maximum density, flange-mounted with incoloy sheath, maximum of 18 kW per element.
 3. Tanks: cement-, glass- or polymer-lined carbon steel, designed, constructed, certified, and stamped in accordance with ASME BPVC-VIII-1-2019 for a 150 psig working pressure, with hand-hole cleanout, drain valve, and baffled inlet. For tanks with porous linings provide a titanium anode rod.
 4. Enclosures: minimum K value of 2.17 Btu·in/(h·ft²·°F) at 80°F for tank insulation, and steel jacket with baked enamel finish.
 5. Warranty: the complete water heater assembly shall be provided with a nonprorated warranty, in writing, by the manufacturer for a period of 1 year from heater start-up. The warranty shall include defects in the design and construction of the assembly, including parts and components. Additionally, there shall be a nonprorated 3 year warranty against tank failure due to rust, and an operational warranty for odor and discolored water due to tank rust or tank lining. The warranty shall cover all costs including parts, heaters, shipping, and labor, with no cost being incurred by the Owner. If repairs are unable to be performed, the water heater shall be replaced with an equal unit.
 6. Manufacturer: Hubbell, Lochinvar, PVI, or A.O. Smith.

2.15 HOT WATER CIRCULATING PUMPS

- A. Single-stage, horizontal inline centrifugal type, with bronze body, bronze impeller, carbon steel shaft, oil lubricated bronze sleeve bearings, flexible coupling, and motor.
1. Manufacturer: Armstrong H series, Bell & Gossett PR series, or Grundfos Circulator series.

2.16 HOT WATER CIRCULATING PUMP TIMERS

- A. Time switch with a 24-hour dial, day-omitting device, self-starting synchronous motor, and removable on-off trippers.

- B. Provide with a NEMA 1 enclosure finished with a baked epoxy paint coating, 0.5" and 0.75" knockouts on bottom, sides and back, and provisions for locking or sealing.
- C. Provide a spring-driven reserve to operate the time switch contacts for at least 16 hours after power failure. On restoration of power the time switch shall transfer to the motor drive and automatically rewind the reserve.
- D. Manufacturer: Intermatic T170CR series, or Tork 7000L series.

2.17 HOT WATER CIRCULATING FLOW CONTROL FITTINGS

- A. Automatic Flow Control Fittings:
 - 1. Flow regulator type fittings with a brass body, removable factory preset flow balancing cartridge and orifice regulator, and stainless steel and brass flow elements. Flow rates shall be controlled to within $\pm 5\%$ of factory preset flow rate over varying pressure ranges. Trim fittings with a union connection, ball valve, and threaded or soldered ends.
 - 2. Manufacturer: Autoflow AC series, Griswold Flowcon series, or Nexus Valves Ultra Matic UM.

2.18 HOT WATER CIRCULATING FLOW METERS

- A. Inline threaded body flow meters with an accuracy of $\pm 5\%$, and operating parameters of 175 psig at 200°F. Meters shall be designed for potable water usage, able to measure flows from 0.5 gpm to 5.0 gpm and mountable in both horizontal and vertical positions.
- B. Manufacturer: Ernst EFI Inflo, Kobold VKP, or Racine Federated EZ-View.

2.19 THERMAL EXPANSION TANKS

- A. Inline expansion tanks shall be the bladder type with welded steel construction, primed and painted exterior, and designed for potable water. Diaphragms shall be FDA approved elastomeric, butyl rubber, designed for a maximum operating temperature of 180°F, and a minimum of 100 psig working pressure. Tanks shall be precharged to a minimum of 40 psig.
 - 1. Manufacturer: Amtrol Therm-X-Trol, Bell & Gossett PTA, or Watts PLT.
- B. Free-standing, vertical type with FDA approved fixed butyl bladder type designed for potable water. Tanks shall be precharged to a minimum of 40 psig. Tanks shall be welded carbon steel, have stainless steel connections, be constructed in accordance with ASME BPVC-VIII-1-2019, have a primed and painted exterior, and be designed for a maximum operating temperature of 240°F and a minimum of 125 psig working pressure.
 - 1. Manufacturer: Amtrol Therm-X-Trol, Bell & Gossett PTA, or Watts DETA.

2.20 RELIEF VALVES

- A. Temperature and pressure relief valves: 0.75" to 2", ASME rated, automatic self-closing pressure and temperature relief type with bronze or copper alloy body, stainless steel springs, non-mechanical seat-to-disc alignment, test lever, thermostat, and stainless steel or FDA approved coated temperature probe. Valves shall be in accordance with ANSI Z21.22-2015/CSA 4.4-2015, and shall be set for 80 psig pressure relief and 210°F temperature relief.
 - 1. Manufacturer: Apollo LF18C-500, Cash Acme FVX-LF series, or Watts LF series.

2.21 MIXING VALVES

- A. Single fixture mixing valves: thermostatic type mixing valve with bronze or brass body, chromium-plated finish, lockable temperature setting, 0.5" inlets with integral check valves, 0.5 gpm minimum flow, and conforming to ASSE 1070-2015/ASME A112.1070-2015/CSA B 125.70-15.
 - 1. Manufacturer: Leonard 270 LF, Powers LFLM495, or Symmons 7-225.
- B. Building master mixing valves: high/low mixing valve assembly with bronze body, self-contained, thermostatically controlled mixing valves with adjustable setpoints, check-stop inlets, union inlet and outlet connections, dial thermometer on discharge and copper piping. High/low assemblies shall have a minimum flow rate of 0.5 gpm and include 2 mixing valves in parallel and an intermediate pressure reducing valve with pressure gauges. Assembly shall be factory assembled and tested in accordance with ASSE 1017-2009. Provide a satin spray finish to the completed assembly.
 - 1. Manufacturer: Leonard TMLF Hi/Low series, Powers LFMM430 Hi/Low series, or Symmons 7 Hi/Low series.

2.22 WATER PRESSURE BOOSTER SYSTEMS

- A. General:
 - 1. The pump assembly shall be manufactured specifically for this Project.
 - 2. Provide a prepiped and prewired skid-mounted factory assembly requiring only three building system connections: water supply, water discharge, and electrical supply. The assembly shall be a variable speed system with vertical diffuser pumps.
- B. Controls:
 - 1. Enclosure: controls shall be housed in a NEMA 1 ventilated stainless steel enclosure mounted on the assembly's stainless steel base frame. Bare steel shall be primed and finished with 2 coats of enamel paint.
 - 2. On/off controls: the system shall be turned on and off by a pressure transmitter mounted on the discharge header, with a NEMA 4X housing, and having a minimum accuracy of $\pm 0.5\%$ full scale.
 - 3. Power Controls:
 - a. A single-point power connection.
 - b. A main through-the-door power disconnect switch, interlocked with door.
 - c. H-O-A multiposition selector switch disconnects for each motor, mounted on door.
 - d. Circuit breakers shall have a minimum 65000 AIC rating, and fuses shall be Class R with a minimum 100000 AIC rating.
 - e. Low voltage control transformer.
 - f. Magnetic motor starters with 3-leg motor starter protection.
 - g. Individual pump running lights.
 - h. Individual pump mechanical failure, with light and pump transfer.
 - i. Field adjustable pressure setpoints.
 - j. 3-phase lightning arrestor.
 - 4. Logic controls: the system shall be controlled by a programmable logic controller and shall include:
 - a. LCD display.
 - b. Operator interface with keypad.
 - c. Field adjustable setpoints.
 - d. Self-diagnostic testing.
 - e. Copper sensing lines, except where the pressure rating is above the tubing's rated pressure, lines shall be stainless steel hydraulic tubing.
 - f. Clock.
 - g. Communication ports with digital inputs and outputs.

- h. Expansion ports.
 - 5. Pump controls: pumps, whether in primary or lag mode, shall have minimum run timers, start delay timers, selector switches, manual alternator, and automatic duty cycle to alternate pumps from lead to lag operation every 24 hour time period.
 - 6. Pressure controls: provide a low suction pressure shutdown set at 10 psig with alarm (with silence button) and light, and a remote low suction pressure alarm with manual reset. Provide panel-mounted suction and pressure gauges. Additionally, provide high suction pressure shutdown with alarm, light and automatic reset, and high system pressure shut down with delay timer, light, and automatic reset.
 - 7. Interface controls: provide status dry contacts that will interface with the building control system to indicate pump system on, low suction pressure, low system pressure, high system pressure, and general alarm.
 - 8. The complete control panel shall comply with UL 508A-2018.
- C. Variable Frequency Drives:
- 1. Provide a variable frequency drive (VFD) for each motor. Each drive shall be sized for the maximum possible amperage draw throughout the programmed sequence of pump operation, and be adjustable frequency.
 - 2. VFDs shall include:
 - a. Pulse width modulation.
 - b. Rotating load starting.
 - c. Keypad operator pad including LCD display.
 - d. Power on and alarm fault display.
 - e. During automatic operation, VFDs shall respond to the signal from the control panel's logic section.
 - f. Electric fault, automatic drive shutdown.
 - g. Automatic restart following power supply failure.
 - h. Operational data displays.
 - i. Complete service diagnostics.
 - 3. Proportion-integral-derivative controls shall be wired directly to the programmable controller, with the logic function incorporated in the controller.
- D. Motors:
- 1. Motors shall be continuous duty open dripproof type, premium efficiency NEMA B with squirrel cage rotor and class F insulation system. Motors shall have a 1.15 service factor that shall not overload at any point on the pump curve. Motors shall be inverter rated for application with variable frequency drives.
 - 2. Motors shall have drive end roller bearings and operate at 104°F ambient. Motors shall meet CSA C390-2010 (R2019), and be equipped with manufacturer's nameplate.
 - 3. Motors shall have a steel shaft, bronze shaft sleeve, and face plate for mounting to horizontal end suction pumps.
 - 4. Motors shall have a steel shaft, and adapter face plate for mounting directly to the top of vertical diffuser pumps.
- E. Pumps:
- 1. 2 vertical multistage diffuser, cast iron type with cast iron stool, stainless steel shaft, stainless steel fitted, replaceable mechanical seals without moving motor, thermal safety valve with purge assembly, flat face for mounting motor to top of pump, and stainless steel impeller.
 - 2. Provide for each pump: vibration isolation mounts, thermal protection, and a nonslam check valve on pump's discharge.
 - 3. Provide isolation valves on each side of each pump. Valves shall be by the same manufacturer and shall be either gate, full port ball, or lug type butterfly type, as the system size and pressure require.

4. Manufacturer: Aurora, Ebara, Patterson, or Peerless. Aurora, Ebara, Paco, Patterson, Peerless, or Taco.

F. Piping:

1. Piping on the assembly between pumps and valves, and including the header, shall be schedule 40 type 304 stainless steel with threaded, grooved, or flanged fittings.
2. Suction and discharge headers shall be supported from the base frame. Provide flanged ends on each header for connections to the building piping.
3. The pressure rating for piping, tubing, and joints shall exceed the Project's maximum pressure requirements.

G. System Assembly:

1. The complete packaged unit shall be assembled on a single primed and painted welded stainless steel base frame, with anchor lugs for bolting to the housekeeping pad. The complete assembly shall be UL listed Category QCZJ for packaged pump systems.
2. The assembly shall be packaged and wrapped to protect the system components, and shipped as an integral unit, unless otherwise required by the Contractor. The unit shall be ready for building plumbing and electrical connections.

- H. System maintenance: each pump, motor, and nonslam check valve shall be serviceable while the balance of the pumping system is still in operation.

- I. Factory test: the complete assembly shall be tested at the factory prior to shipment, and certified in writing that it was tested at, and meets the Project's maximum flow requirement with the project's scheduled inlet minimum pressure. The test report shall accompany the assembly as part of its official documentation.

- J. Documentation: system drawings, description of control panel with wiring diagrams, documentation of the third party labeling (that the components are a system for the intended use), factory test report, Operation and Maintenance Manual with parts list, and system warranty.

- K. Warranty: the assembly, in whole and in part, shall be warranted in writing by the manufacturer for a period of 18 months from shipment or 12 months from start-up, whichever comes first. The warranty shall include defects in the design and construction of the assembly, including parts and components. The warranty shall cover shipping cost of parts and components to and from the manufacturer to the site, and all Contractor labor, travel cost, and overtime labor rates if applicable, for repairs.

- L. Manufacturer: Bell & Gossett, Canariis, Delta-P, Flo-Pak, QuantumFlo, or SyncroFlo.

2.23 FLEXIBLE CONNECTORS

- A. As specified in Section 220010, Plumbing General, for pressure and temperature of intended service.

2.24 WATER METERS

A. Turbine Meters:

1. Potable cold water meters 1.5" to 6": with bronze, copper alloy, or stainless steel main casing, magnetic drive, remote reading, permanently sealed register, hydronamically balanced floating rotor, stainless steel trim, $\pm 1.5\%$ register accuracy, leak detection, and meeting AWWA C701-2015 and NSF 61-2019.
2. The meter shall measure flow and provide totals in gallons.

3. Provide a factory installed electronic encoder on the meter, with probes to detect current flow, total volume to date, and leak detection. The encoder shall be wired to the BAS, and have software able to communicate the required information in digital format.
4. Manufacturer: Badger Recordall Turbo series, Hersey MVR series, or Neptune HP series.

2.25 ACCESSORIES

- A. Gaskets in water piping: 0.063" thick red rubber or asbestos-free composition sheet type, selected for the pressure, temperature and service of the specific joint.
- B. Bolts and nuts: ASTM A307-2014e1, Grade B.
- C. Stack sleeves: coated cast iron stack sleeve, with caulking recess, flashing flange, nonpuncturing flashing clamp ring, and pressure ring.
 1. Manufacturer: Josam 26450, Smith 1720, or Zurn Z-195.

2.26 TUBING AND PIPING SLEEVES

- A. Underground Tubing and Piping:
 1. For 0.5" to 1" noninsulated tubing and piping direct buried underground, wrap the complete length with a minimum of 4 mil virgin polyethylene sleeve conforming to ASTM D1248-2016. Sleeves for cold water shall be blue, and red for hot water.
 2. Manufacturer: IPS Water-Tite, Northtown, or Oatey.
- B. Tubing and Piping in Contact with Concrete:
 1. For 0.5" to 1" noninsulated tubing and piping installed in contact with concrete slabs or concrete blocks, wrap the effected length with a minimum of 25 mil virgin polyethylene conforming to ASTM D1248-2016. Sleeves for cold water shall be blue and red for hot water.
 2. Manufacturer: Great Bay Products, or IPS Water-Tite.

2.27 FILTERS

- A. Ice Makers and Water Dispenser Filters:
 1. A changeable cold water filter system with minimum of 2 in-line filters, pressure gauges, 0.75" inlet and outlet connections, and wall mounting bracket with manifold. The system shall meet NSF and FDA requirements for safe drinking water.
 2. Filter systems shall be able to remove sediment 0.5 micron in size and larger, and reduce chloramine, chlorine, and cysts. Filters shall have a built-in inhibitor to reduce lime scale build-up.
 3. Filter systems shall have a minimum capacity of 70,000 gal volume usage with a flow rate of 5.0 gpm and a working pressure of 100 psig.
 4. Manufacturer: Bunn EQHP-TWIN 70L, Everpure CB20-302E, or 3M ICE260-S.

PART 3 - EXECUTION

3.1 GENERAL PIPING INSTALLATION

- A. General:
 1. Install all piping, fittings, and joints in accordance with the applicable manufacturer's instructions whether underground or aboveground.

2. Piping shall be cut to measurements established at the site and worked into place without springing or forcing.
3. Use concentric reducing fittings between different size pipes.
4. Ream steel, brass and copper pipe after cutting, turn on end and knock loose dirt, scale, and filings from interior of pipe.
5. Slope water piping to drain back to the mains.
6. Provide plastic pipe manufacturer's recommended expansion and contraction loops.
7. Install piping that is to receive insulation in a manner that when the insulation is installed, the finished wall of the insulation is not crushed nor in contact with any adjacent surface or equipment.

B. Underground:

1. Install water piping outside the building in trenches separate from sewers.
2. Excavation and backfill: as specified in Section 220010, Plumbing General.
3. Underground piping shall be connected to the exterior service line, or capped or plugged if the exterior service is not in place.
4. Block ductile iron water pipe with concrete poured in contact with undisturbed earth. Provide tie rods for outside joints.
5. Piping installed below a footing's bottom elevation shall be installed a minimum of 12" horizontally from the footing for each 12" of depth below the footing.

C. Aboveground:

1. Piping shall be installed to permit free expansion and contraction, as controlled by pipe anchors, without damage to joints, hangers, or the building. Arrange piping to minimize stresses caused by expansion and contraction.
2. Group exposed pipe together and arrange control valves at fixtures for ease of operation.
3. Install piping so as to preserve access to valves and equipment and to provide the maximum headroom possible.
4. Provide offsets to maintain ceiling height and to coordinate with other trades.
5. Install exposed piping such that when insulation is applied it will not come in contact with adjacent surfaces.

D. Piping Joints:

1. General:
 - a. Isolate joints between dissimilar metals and connections to tanks with dielectric fittings.
 - b. Provide flanges, grooved couplings, or unions at connections to equipment.
 - c. Install mechanically grooved couplings and press fittings in accordance with the manufacturer's instructions, and provide factory trained personnel for installation.
2. Solder joints: pipe ends shall be cut square, deburred, cleaned and assembled in accordance with ASTM B828-2016.
3. Threaded joints: screw-thread joints shall be made with cut tapered threads. Joints shall be made tight with Teflon tape. Not more than 2 threads shall show after the joint is made tight, except no threads shall show in exposed chromium-plated piping.
4. Flanged joints: except at connections to equipment, flanged joints shall be made with ring type gaskets, extending to inside of bolt holes.
5. Press fitting joints: shall be made using the manufacturer's specific equipment for the piping joint being made, and by manufacturer trained personnel. Each pipe end shall be abutted full length into the fitting and marked accordingly.

3.2 PIPING, FITTINGS AND JOINTS

A. General:

1. Do not mix plastic pipe and fitting manufacturers. Use only the manufacturer's products approved by way of product data submittals.

B. Copper Tubing:

1. Noninsulated piping installed in masonry construction shall be painted 2 coats of asphaltum paint.
2. Clean, prime, and paint exposed noninsulated piping with 2 coats of glossy silver paint.

3.3 SPECIALTY PIPING JOINTS

A. Unions:

1. Provide in each piping connection to each piece of equipment where equipment may be removed.
2. Unions are not required where flanges or roll-grooved mechanical joint couplings are provided.

B. Flange Joints:

1. Provide in piping connections to equipment where flanges are provided.

3.4 VALVES

A. General:

1. Provide an isolation valve in the cold water service line near the point of entrance into the building. On the building side and near the gate valve, install a drain leg with 0.75" hose bib.
2. Provide a valve in each water supply connection to hose bibs, wall hydrants and water using equipment.
3. Install valves in clear locations so that handles and hand wheels are easily accessible for completely opening and closing of the valves.

B. Globe Valves:

1. Provide globe valves in each water supply connection to sinks, water coolers, and any fixture provided by others, except where globe type stop valves are furnished with fixtures.

C. Butterfly Valves:

1. Butterfly valves may be used in lieu of gate valves indicated herein in systems operating at a maximum operating pressure of 150 psig.

3.5 AUTOMATIC FLOW BALANCING VALVES

- A. Install strainer valve upstream of automatic flow balancing valve.

3.6 STRAINERS

- A. Install in the inlet to each pump, pressure reducing valve, flow control valve, thermostatic mixing valve, backflow preventer, and as indicated on the Drawings or specified herein.

3.7 HYDRANTS

A. General:

1. Provide Owner with a loose key for each hydrant and obtain a receipt listing quantity and type of hydrant keys.

B. Wall Hydrants:

1. Install 18" above finished grade, except where building conditions and/or grade prevents the installation. Modify installation height as required, up to 36" above finished grade, where 18" will not work.

C. Roof Hydrants:

1. Order length of hydrant so that the wheel handle is approximately 27" above the finished roof.
2. Ensure that roof hydrants will winterize and provide manufacturer's winterizing information to Owner.

3.8 BACKFLOW PREVENTERS

- A. Drain line from each unit shall be DWV copper run full size to floor drain.

3.9 VACUUM BREAKERS

A. Pressure Type:

1. Install where water flow is continuous.
2. Install a minimum of 12" above the overflow level of the device being served.

B. Atmospheric Type:

1. Install where water flow is intermittent.
2. Install a minimum of 6" above the overflow level of the device being served.

- C. Install where spillage of water will not cause damage to room surfaces or equipment.

3.10 TRAP PRIMERS

- A. Connect trap primer lines to the drain tailpieces where field conditions prohibit connection to the trap primer connections on the drain bodies.

- B. Install trap primers with a straight downward slope to allow drainage from the trap primer valve.

3.11 WATER HAMMER ARRESTERS

- A. Install water hammer arresters in accordance with PDI WH201-2017.

3.12 PRESSURE GAUGES

- A. Provide filled gauges at the water pressure booster system.

3.13 THERMOMETERS

- A. Thermometer stems shall be installed in pipe tees with the stem in the water way flow stream. Thermometers shall be located so as to be easily read from 4.5' above the floor.

3.14 WATER HEATERS

- A. Install heaters level and stable.

- B. Start-up: a factory trained representative shall start-up each water heater. The representative shall submit a start-up report to the Contractor for inclusion in the Operation and Maintenance Manual.

3.15 HOT WATER CIRCULATING PUMPS

- A. Support pumps independently from piping by mounting at 48" above floor on wall with an angle iron frame.
- B. Do not restrain motor from floating on frame.

3.16 HOT WATER CIRCULATING PUMP TIMERS

- A. Set to turn the circulating pump on at hours set by Owner.
- B. Coordinate the day-omission setting with the Owner.

3.17 THERMAL EXPANSION TANKS

- A. Support tanks with hangers independently from adjacent piping or on the floor where floor bases are provided.

3.18 MIXING VALVES

- A. Connect mixing valves to the piping systems per the manufacturer's published installation recommendations.
- B. Secure each mixing valve assembly to a backboard mounted on the wall.
- C. Install each sensing bulb in a minimum 1" tee so that the bulb is completely washed by the flow.

3.19 WATER PRESSURE BOOSTER SYSTEMS

- A. Start-Up:
 - 1. A factory trained representative shall start-up the water pressure booster system. The Contractor shall not start the system without the factory trained representative.
 - 2. The representative shall check the electrical wiring connection, and the building piping connections before turning on the pump system. A start-up report shall be filled out by the representative and given the Contractor for inclusion in the Operation and Maintenance Manual.
- B. Owner Training:
 - 1. The Owner shall be trained by a factory trained representative.
 - 2. The training shall include:
 - a. The replacement of the motor, mechanical seals, and pump impeller.
 - b. Replacement of control panel fuses, chips, and pilot lights.
 - c. System operation, trouble-shooting, alarms, and re-set features.
- C. Dual power feed: provide 2 separate incoming power feeders, one primary and one standby, to a separate electrical panel (independent of the booster system) with electrical sensing and automatic power change-over if de-energizing of the primary feeder occurs so that the pumping system will remain in operation. Provide a single-point power feed to the booster pump's control panel.

- D. Pipe over-temperature discharge pipe to floor drain.

3.20 WATER METERS

- A. Install meter, piping, valves, and accessories per the manufacturer's requirements, and as indicated on the Drawings.
- B. Provide isolation valves, union or flange connections, and a separate wye pattern strainer at the meter's inlet.

3.21 TUBING AND PIPING SLEEVES

- A. Install sleeve over tubing or piping before installation, allowing room for expansion and turns.
- B. Inspect the sleeve closely for cuts or tears. Tape any cut or tear with water proof tape, wrapped around the sleeve and tubing or piping.
- C. Terminate sleeve a minimum of 10" above the floor.

3.22 ROOF PENETRATIONS

- A. Where pipes pass through the roof, flash with a sheet of 4 psf lead flashing extending at least 8" from the clamping ring in all directions.
 - 1. Provide a waterproof caulked joint in the top hub of each stack sleeve after the riser has been installed through the sleeve.
- B. Flash and counter-flash pipes passing through the roof with 4 psf sheet lead, not less than 18" square.

3.23 PIPING AND JOINT PRESSURE TESTING

- A. General:
 - 1. Test piping and joints under floor slabs before slabs are poured.
 - 2. Tests shall be made while piping and joints are exposed to view.
 - 3. Screwed, flanged, and grooved joints that leak shall be taken apart and reassembled.
 - 4. Soldered, brazed, and clamped joints that leak shall be cut out and replaced.
 - 5. Submit a statement certifying that piping and joints are tight and have passed the specified test.
- B. Piping Systems:
 - 1. Test cold water, hot water, and hot water circulating systems piping and joints by capping all openings and applying a hydrostatic pressure of 125 psig for 1 hour without any drop in pressure. Disconnect the pump source prior to and during testing. Where a system is tested in sections, each section shall be subjected to the same test.

3.24 PIPING SYSTEM TEMPERATURE TESTING

- A. Hot Water Systems:
 - 1. Following the installation of the piping systems, energize the water heaters and circulation pumps and bring the piping systems up to operating temperatures.
 - 2. Flow the hot water systems then allow the systems to stand for one hour before beginning testing.

3. Perform hot water temperature checks at each fixture, and verify that the correct water temperature, as indicated on the Drawings, is flowing from each hot water outlet.
4. Where any fixture's hot water temperature is incorrect, make adjustments as required to the water heaters, mixing valves, balancing assemblies, and circulation pumps.

B. Hot Water Circulation Systems:

1. For automatic flow control balancing fittings (preset from the manufacturer) verify that the correct flow fitting is installed, and that the accumulated flow is returning to the water heater. If flow is lower than indicated on the Drawings, remove and clean the flow control fittings.

C. Documentation:

1. Provide a document for the Operation and Maintenance Manual that dates, locates, and records the flow settings at each balancing station, and the temperatures recorded at each fixture.
2. Provide a copy of the meg-ohmmeter report for the Operation and Maintenance Manual.

3.25 CLEANING AND DISINFECTION

A. Domestic Water Piping:

1. Clean and disinfect inside water piping prior to placing the system in operation.
2. Purge domestic cold water, and hot water and hot water circulating piping, including heaters, pumps, tanks, and fixtures.
3. Flush the piping systems with potable water from the municipal supply system until water runs clear.
4. Fill the system with a water/chlorine solution containing a minimum 200 ppm chlorine. Isolate the piping systems and allow to stand for 4 hours.
5. Flush the systems with clean, potable water from the municipal supply system until the chlorine in the system is the same level as the municipal supply system.
6. Submit water samples for biological examination by laboratories approved by the local health authority. Samples shall be taken in the presence of the Owner.
7. Repeat the procedures and resubmit water samples as required to pass the biological test. Minimum acceptance test results shall be 0.0 colonies of coliform bacteria.
8. Provide results of tests.
9. Materials and test methods shall comply with AWWA C651-2014.

- B. Strainers: after final flushing of the water system, remove strainer baskets for cleaning and disinfection. Reinstall baskets and ensure that caps are leak tight.

END OF SECTION 224400

SECTION 224900 - PETROLEUM, OIL AND LUBRICANT SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other plumbing systems are specified in other Sections of Division 22.
- B. Refer to Section 220010, Plumbing General, for a list of plumbing Sections included in this specification.
- C. This Section includes furnishing, installing, and testing petroleum, oil, and lubricant systems, including fuel oil, gasoline, grease, diesel fuel, motor oil, transmission fluid, and waste oil.
- D. Electrical power wiring of fuel and oil pumps associated with the petroleum, oil, and lubricant systems is covered under Division 26.
- E. Electrical low voltage wiring and wiring of packaged equipment and accessories shall be provided under this Section.

1.2 QUALITY ASSURANCE

- A. Petroleum, oil, and lubricant systems shall conform to the following:
 - 1. State and local codes.
 - 2. NFPA 30-2018.
 - 3. NFPA 30A-2018.
 - 4. NFPA 31-2020.
 - 5. NFPA 37-2018.
 - 6. NFPA 70-2020.
 - 7. North Carolina State Electrical Code-2017.
- B. Welder certification: welders shall be certified under the rules of the National Certified Pipe Welding Bureau and qualified by either the National Certified Pipe Welding Bureau or an independent testing laboratory for the procedures used on this Project.
- C. Welding procedures: in accordance with ASME B31.1-2018 and ASME B31.9-2017 for the service involved. Welds shall be full penetration type, accomplished by proper beveling and spacing of pipe ends. Where backing rings are specified herein, root pass shall penetrate into the backing ring.

PART 2 - PRODUCTS

2.1 PIPING, FITTINGS AND JOINTS

- A. General:
 - 1. Piping and fittings sizes listed are nominal inside diameter.
- B. Fuel oil, aboveground:
 - 1. Piping: black steel, schedule 40, ASTM A53/A53M-2018.
 - 2. Fittings 2" and larger: standard weight black steel, butt weld, ASME B16.9-2018.
 - 3. Fittings smaller than 2": standard weight socket-weld steel, ASTM A181/A181M-2014.
 - 4. Joints: welded.

C. Tank vent, aboveground:

1. Piping: galvanized steel, schedule 40, ASTM A53/A53M-2018.
2. Fittings: standard weight galvanized malleable iron, ASTM A338-1984 (2018).
3. Joints: threaded.

2.2 SPECIALTY PIPING JOINTS

A. Unions:

1. For steel piping 2" or smaller: ground joints with brass-to-iron seats.
2. For piping larger than 2": flange and gasket type. Flanges in steel piping shall be cast iron.
3. For galvanized piping: galvanized.

B. General:

1. Valves shall be of the same manufacturer, unless specified otherwise herein.

C. Ball Valves - Fuel Systems:

1. Ball valves, 0.5" to 2": class 150, 2-piece bronze body with full port chromium-plated ball, blow-out proof stem, lockable lever handle, threaded ends, UL 842-2015 for flammable liquids, and 600 psig wog.
 - a. Manufacturer: Apollo 80-100, Jomar T100, Kitz 68, Milwaukee BA475B, or NIBCO T-585-70-UL.

D. Check Valves:

1. Check valves, 0.5" to 2": class 150, horizontal swing type with carbon or stainless steel body, seat, and disc, screw cap, and threaded ends for 300 psig wog.
 - a. Manufacturer: Kitz 34, or approved equal.

E. Solenoid Valves:

1. Solenoid valves, 0.5" to 2": class 300, plunger type with stainless steel body, piston, and plunger, Teflon body seal and orifice seal, 1" electrical conduit connection with Class H encapsulated leads, and threaded ends. Valves shall be powered open and normally closed.
 - a. Manufacturer: Magnatrol Type K, or approved equal.

2.3 STORAGE TANKS

A. Storage Tanks - Steel/Concrete Vaulted, Aboveground:

1. Factory-assembled, concrete vaulted, aboveground storage tanks including the following features:
 - a. Rectangular, welded steel primary vessel listed in accordance with UL 142-2019 for aboveground storage of flammable and combustible liquids. Vessels shall be primed with rust resistive primer. An air gap shall separate the primary tanks from the concrete vaults. The space shall be proven liquidtight by a vacuum test conducted at the factory. Pipe risers shall be isolated from direct contact with the concrete with a fire-rated seal.
 - b. Vault construction of 6" reinforced concrete providing a fire-rated assembly with inner coating and exterior sealer finish.
 - c. Reinforced sealer finished concrete supports for seismic stability and flood restraint with corrosion resistant anchor bolts.
 - d. Steel containment enclosure on the top centerline of the vault. The enclosure shall include a hinged lid, sealer finish, and a liquidtight seal to the concrete vaulting.

- e. An exterior ladder, tank top platform, and handrails constructed of galvanized steel components.
 - f. Minimum openings in the primary vessel and concrete vault for normal vent, emergency vent, vent to the annular space, fuel suction, fuel return, tank fill, fuel gauge, and monitor probe to annular space.
 - g. Assemblies shall meet the requirements of NFPA 30-2018 and UL 2085-1997(R2010) and shall carry a 30-year warranty.
2. Manufacturer: Phoenix Products, Containment Solutions, or approved equal.

2.4 STORAGE TANK EQUIPMENT AND ACCESSORIES

A. Tank Accessories - Fuel Oil:

1. Fill Assemblies:
 - a. Fill connections: bronze, watertight, fill adaptors with heavy duty, corrosion-resistant locking caps, with Buna-n gaskets.
 - 1) Manufacturer: EBW 306/777, Emco A30/A97, or OPW 633T/634TT.
 - b. Drop tubes: integral float and isolation valve.
 - 1) Manufacturer: EBW 708, Emco A1100, or OPW 61-50.
2. Vent Assemblies:
 - a. Vent caps: aluminum body with brass screen, upward flow type.
 - 1) Manufacturer: EBW 800, Emco A4103, or OPW 23.
3. Fuel Suction Assemblies:
 - a. Suction check valves: double-poppet type with screen.
 - 1) Manufacturer: EBW 151, Emco A0439, or OPW 86/92.
 - b. Extractor fittings for suction check valves:
 - 1) Manufacturer: EBW 320, or OPW 233P.

2.5 FUEL PUMPS

- A. Fuel oil return pump shall be a cast iron gear pump mated to an electric motor providing a minimum pump output speed of 1700 rpm. The pump shall be certified to be operational with No. 2 diesel, include an adjustable, internal relief valve, and mechanically sealed.
 1. Manufacturer: Viking FH456 with SK172.1-71L-2.32-3 or approved equal.

2.6 LEAK DETECTION SYSTEMS

- A. Leak detection systems shall include a microprocessor-based tank gauge, liquid crystal display, painted steel enclosure with hinged front door, printer, sensors, and interconnecting cables. Operating power shall be 120 V AC. The system shall have the capacity to monitor up to 4 tanks with the following sensors:
 1. Liquid level sensor within the tank.
 2. Generator enclosure sensor.
 3. Fill box sensors.
 4. Interstitial sensors.
- B. Tank liquid level sensors shall operate on the magnetostrictive principle and shall include temperature compensation and water detectors. Sensors shall be certified to detect product loss as small as 0.2 gph with a probability rate of 95%.

- C. Interstitial sensors shall include liquidtight cables and caps with wire grips.
- D. Manufacturer: Incon, Ronan, or Veeder-Root.

PART 3 - EXECUTION

3.1 GENERAL PIPING INSTALLATION

A. General:

1. Piping shall be cut to measurements established at the site and worked into place without springing or forcing.
2. Use concentric reducing fittings between different size pipes.
3. Ream piping end after cutting to remove burrs, turn on end to knock loose any filings from interior of pipe.
4. Take-offs from horizontal piping shall be above the pipe's center line at an angle of 45° or greater above the horizontal.
5. Pitch/grade: piping shall be installed with sufficient pitch to ensure drainage and venting.

B. Aboveground:

1. Piping shall be installed to permit free expansion and contraction without damage to joints, hangers, or the building. Arrange piping to minimize stresses caused by expansion and contraction.
2. Group exposed pipe together and parallel at the same side distance apart.
3. Install piping so as to preserve access to valves and equipment and to provide the maximum headroom possible.
4. Provide offsets to maintain ceiling height and to coordinate with other trades.

C. Piping Joints:

1. Welded Joints:

- a. Mitering or notching pipe to form elbows and tees will not be permitted. Field and shop bevels shall be in accordance with the standards specified herein and shall be done by mechanical means or flame cutting. Where beveling is done by flame cutting, surfaces shall be cleaned of slag, scale and oxidation prior to welding. Before welding, the component parts to be welded shall be aligned so no strain is placed on the weld when finally positioned. Height shall be aligned so that no part of the pipe wall is offset by more than 20% of the wall thickness. Flanges and branches shall be set true. This alignment shall be preserved during the welding operations. Connections larger than 6" shall be made with backing rings at welds.
 - b. Where the temperature of the component parts being welded reaches 32(F or lower, the material shall be heated to approximately 100(F for a distance of 3' on each side of the weld before welding, and the weld shall be finished before the material cools to 32(F.
 - c. Welders shall stamp each weld with his personal symbol or code number.
2. Flanged joints: at connections to equipment, flanged joints shall be made with ring type gaskets, extending to inside of bolt holes. Flanged connections to equipment shall be made with full-face gaskets to match flanges on equipment.
 3. Insulate joints between dissimilar metals and connections to tanks with dielectric fittings.
 4. Provide flanges or unions at connections to equipment.

3.2 SPECIALTY PIPING JOINTS

- #### A. Unions: provide in each connection to each piece of equipment, except where flanges are used, so it may be removed.

3.3 STORAGE TANKS

- A. Submit tank registration forms to governing authorities in accordance with local regulations.
- B. Tanks shall be installed in accordance with the manufacturer's published installation checklist. Submit a signed copy of the installation checklist.

3.4 STORAGE TANK EQUIPMENT AND ACCESSORIES

- A. Wiring and conduit: as specified in Division 26.
- B. Provide control wiring, in 0.75" rigid steel conduit as specified in Division 26, from liquid level gauges, remote status panels and leak detection panels to associated sensors.
- C. Furnish fuel required to conduct tests of fuel burning equipment. Fuel which has been in the storage tanks longer than 24 months shall be removed prior to the tests. At the completion of the tests, fill tanks to full capacity with new fuel.
- D. Install liquid level gauges and leak detection control panels on painted plywood backboards.
- E. Interconnect the solenoid valve with the generator units such that when the engine receives signal to operate, the solenoid valve receives power to open.

3.5 FUEL PUMPS

- A. Install fuel oil return pump on a concrete pad adjacent to the aboveground storage tank. Anchor the pump and electric motor to the concrete pad.
- B. Provide 1/8" / 1' slope of concrete up to the electric motor and pump assembly such that rainwater flows away from the pump.

3.6 STORAGE TANK TESTING

- A. Tanks and tank connections shall be tight with no leakage.
- B. Prior to setting tanks in the ground, pressure test at 3 psig to 5 psig per the manufacturer's instructions. Outlet fittings shall be soaped to allow easy visual inspection during this test.
- C. If a tank leaks, replace it with a new tank. Damaged tanks shall not be repaired.
- D. If there is a leak at the tank openings, tighten the plug and repeat the test.
- E. After each tank has been installed with connections and piping, perform a precision test to ensure final tightness of the system.

3.7 PIPING AND JOINT TESTING

- A. General:
 - 1. Piping and joints shall be leak free.
 - 2. Tests shall be made while piping and joints are exposed to view, and prior to connections to tanks, equipment, or dispensers.

3. Gaugeable fitting joints shall be individually tested with factory-supplied inspection gauge prior to the system's pressure test. Under-tightened joints shall be retightened and reinspected. Over-tightened joints shall be replaced and reinspected.
 4. Submit a statement certifying that piping and joints are tight and have passed the specified test.
- B. Test fuel systems piping hydraulically at 50 psig for 1 hour. Test containment piping pneumatically for 1 hour at 5 psig. Disconnect hydraulic source prior to and during testing. Where the system is tested in sections, each section shall be subjected to the same test. Tanks shall be isolated from the piping during testing.
- C. Piping and Joint Leakage:
1. Leaks shall be repaired or replaced, and the system retested as indicated above.
 2. Any pipe that leaks shall be removed and a new piece installed.
 3. Screwed and flanged joints that leak shall be taken apart, inspected for damage and debris, and reassembled.
 4. Brazed joints that leak shall be cut-out and replaced.
 5. Gaugeable fitting joints that leak shall be taken apart, inspected for damage and debris, and reassembled per the manufacturer's instructions.
 6. Defective welds shall either be cut out and rewelded or ground down to base metal and rewelded. Reworked welds shall be tested as specified herein.

END OF SECTION 224900

SECTION 230010 – HVAC GENERAL

PART 1 - GENERAL

1.1 DESCRIPTION

- A. These heating, ventilating and air conditioning (HVAC) provisions specified herein apply to all Sections of Division 23.
- B. Refer to the General and Supplementary Conditions and Division 01 for special requirements and conditions which apply to all Sections of Division 23.
- C. This Section includes responsibilities and obligations in support of the performance verification specified in Section 230090, HVAC Performance Verification, and commissioning specified in Section _____.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. North Carolina State Energy Conservation Code-2018.
 - 2. North Carolina State Mechanical Code-2018.
- B. Codes, standards and regulations specified herein refer to the edition date. Revisions and addenda to these codes, standards and regulations shall be part of these specifications. Provisions of referenced codes, standards, and regulations do not create duty or responsibility by the Engineer or the Owner, unless otherwise specified herein.
- C. Codes, standards and regulations referred to are minimum standards. Where the requirements of these specifications or drawings exceed those of the codes, standards and regulations, the drawings or specifications shall govern.
- D. HVAC/Electrical Design Coordination:
 - 1. The power ratings of motors and other HVAC equipment and the electrical characteristics of electrical systems serving them, as specified herein and indicated on the Drawings, have been established as minimums which will allow that equipment to satisfactorily function while producing the required capacities. These power ratings include a safety factor deemed appropriate to accommodate common differences between design parameters and field construction practices. Under no circumstances shall equipment with power ratings less than those indicated on the Drawings or specified herein be provided.
 - 2. Reasonable efforts have been made to coordinate the electrical requirements of the HVAC equipment with the electrical systems serving that equipment. Differences among manufacturers of HVAC equipment make it impossible to produce a single electrical design which will satisfy the varying electrical requirements of those manufacturers. Consequently, the Contractor shall coordinate the electrical requirements of the HVAC equipment actually furnished on this Project and provide the electrical systems required by that equipment. This coordination effort shall be completed prior to the installation of either the HVAC equipment or the electrical systems serving that equipment. Electrical system revisions required to coordinate with the HVAC equipment actually furnished shall be provided at no additional cost to the Owner.
- E. Low-Emitting Materials
 - 1. Adhesives, sealants, sealant primers, paints, and coatings used inside the building (defined as inside the weatherproofing envelope and applied on-site) shall be tested and determined compliant with

- California Department of Public Health (CDPH) Standard Method v1.2-2017, using the applicable exposure scenario.
2. Methylene chloride and perchloroethylene shall not be intentionally added in paints, coatings, adhesives, or sealants that are applied on-site.
 3. All paints and coatings that are wet-applied on site and used inside the building must meet the applicable VOC content limits of one of the following:
 - a. California Air Resources Board (CARB) 2019, Suggested Control Measure (SCM) for Architectural Coatings
 4. All adhesives and sealants that are wet-applied on site and used inside the building must meet the applicable VOC content requirements of SCAQMD Rule 1168, July 1, 2017.
 5. All exterior applied adhesives, sealants, coatings, and waterproofing materials must meet VOC content limits of BOTH of the following:
 - a. California Air Resources Board (CARB) 2019 Suggested Control Measure (SCM) for Architectural Coatings
 - b. South Coast Air Quality Management District (SCAQMD), Rule 1168, effective July 1, 2017.
 - 1) Small containers of adhesives and sealants subject to state or federal consumer product VOC regulations are exempt.
 6. Paint that is applied on site shall not contain lead or any intentionally added cadmium.

1.3 SPACE CONDITIONS

- A. Drawings are diagrammatic in nature and, unless explicitly dimensioned, indicate approximate locations of apparatus, equipment, ductwork and piping. Changes in the location, and offsets, of same which are not shown on the Drawings but are necessary in order to accommodate building conditions and coordination with the work of other trades, shall be made during the preparation of coordination drawings and prior to initial installation, without additional cost to the Owner.
- B. Provide access to equipment and apparatus requiring operation, service or maintenance throughout the life of the system.
- C. Piping, equipment, or ductwork shall not be installed in electrical equipment rooms, elevator equipment rooms, or elevator shafts unless specifically indicated on the Drawings. In addition, piping, ductwork, or mechanical equipment shall not be installed in the space equal to the width and depth of switchgear, switchboards, panelboards, and motor control centers from floor to structure above nor within the working space in front, rear and/or side (where rear and/or side access is required to work on equipment) of electrical equipment (switchgear, switchboards, panelboards, motor control centers, variable frequency drives, transformers, and starters). Dimensions of the working space shall be a minimum depth of 42" horizontally, the width of the equipment or 30", whichever is greater, and the height of the equipment or 78", whichever is greater. Minimum depth shall be increased to 60" for equipment rated over 600 V.

1.4 ASBESTOS MATERIALS

- A. Materials containing asbestos or any trace of asbestos related materials shall not be used on this Project.

1.5 DEFINITIONS

- A. Exposed piping, conduit, or ductwork is that which can be seen when the building is complete without opening or removing access doors or panels or accessible ceiling components.
- B. Other piping, conduit, and ductwork is considered to be concealed.

1.6 RELATED WORK DESCRIBED IN OTHER DIVISIONS

- A. Installation of access panels in wall and ceiling construction.
- B. Cutting, coring, waterproofing, and patching of walls, floors, ceilings, roofs and structure of existing buildings.
- C. Painting, except as specified herein.
- D. Electric power, interlock, and control wiring, except as specified herein.
- E. Installation of starters, contactors, thermal overload switches, and remote push buttons, except as specified herein.
- F. Fire alarm initiating devices, control modules, and monitoring modules.
- G. Curbs, flashing, and pitch pockets for equipment on roof, except as specified herein.
- H. Structural supports for the heat rejection equipment and roof-mounted fans.
- I. Door grilles.
- J. Louvers and screens.

1.7 SUBMITTALS

- A. Within 15 days after notice to proceed, submit a schedule indicating the proposed submission date of each submittal specified herein. Schedule shall anticipate the submittal review time, the possible need for resubmittals, and the time required for fabrication, shipping and integration into the construction sequence. Architect will advise of any conflicts in reviewing submittals that the proposed schedule presents.
- B. Submittals shall be prepared in a line-by-line format corresponding to these Specifications and shall indicate compliance with each requirement specified herein and indicated on the Drawings.
 - 1. In addition to any other transmittals or cover sheets used, fill out and attach to each individual submittal a copy of the Cover Sheet for Submittals to Newcomb & Boyd included at the end of this Section.
 - 2. Indicate manufacturer's installation instructions.
 - 3. Indicate deviations, if any, including any from the manufacturer's installation instructions.
 - 4. Reproductions or electronic versions of design drawings shall not be used in the preparation of shop drawings.
 - 5. Resubmittals that are required to address review comments shall include a cover transmittal with a written explanation of how each review comment has been addressed.
 - 6. Submittals not specifically required, or not complying with the format requirements, will be returned unreviewed.
 - 7. Shop drawings and submittals shall be provided in portable document format (PDF). PDF files containing multiple drawings or components shall include an index of the file contents and electronic bookmarks.
- C. Shop drawings shall include the following:
 - 1. Trade shop drawings (i.e., HVAC equipment room drawings, HVAC piping system drawings, HVAC sheet metal system drawings, and electrical main feeder raceway drawings) shall be submitted within 30 days after award of contract.

2. Approved trade shop drawings shall be utilized as the basis for the coordination drawings. Coordination drawings shall be submitted within 30 days after approval of trade shop drawings.
3. Coordination drawings shall utilize either manual or electronic means of analyzing the work of each trade in spatial relationship with other trades. Locations of conflicts between trades, and the proposed resolution for each conflict, shall be noted on the coordination drawings submitted.
4. No work shall be fabricated and/or installed prior to receipt by the Contractor of approved trade shop drawings and approved coordination drawings without specific written authorization from the Architect. No change orders will be approved or design assistance provided for remedial field coordination activities for work fabricated and/or installed prior to receipt by the Contractor of approved trade shop drawings. and approved coordination drawings.

D. HVAC submittals shall include the following:

1. Performance Verification Supervisor qualifications.
2. Coordination drawings, with dimensions and elevations, of HVAC work, including ductwork, equipment, piping with fittings, valves, dampers, accessories and sleeves coordinated with the work of other trades, including plumbing, fire suppression, electrical, structural, and architectural, minimum 1/4" = 1'-0" scale.
3. Insulation.
4. Seismic and wind restraint devices, including calculations, restraint selection, installation details and written confirmation that a licensed engineer prepared the calculations.
5. HVAC underground preinsulated piping systems, including drawings with dimensions and bury depths, fittings, valves, accessories, thrust blocks, expansion loops, factory-prepared calculations of thrust and expansion, coordinated and shown with the work of other trades including plumbing, civil, fire suppression, electrical, structural and architectural, minimum 1" = 20'-0" scale.
6. Vibration isolation, including spring data, manufacturer's equipment operating weight, actual load distribution and actual deflection at each loading point for each piece of isolated equipment. Shop drawings for piping isolators shall be made on prints of the piping shop drawings. For floating riser support system, include structural loads, stresses, and isolator deflections at minimum and maximum operating temperatures for piping, elbows, accessories and equipment connections.
7. Air handling units with coil, fan, and filter data, and fan curves.
8. Automatic temperature controls with information as specified in Section 238000, Automatic Temperature Controls. Each control device, software, sequence of operation, and control schematic and I/O summary submittal shall be cross-referenced to a specific requirement in these Specifications and Drawings.
9. Centrifugal water separators.
10. Chillers.
11. Coils.
12. Combination fire/smoke dampers, including static pressure drop for each damper.
13. Dampers.
14. Ductless split systems.
15. Ductwork and fittings, factory-fabricated.
16. Electric heating coils, including diagrams showing arrangement of circuits to prevent stratification of hot and cold air for coils controlled at 3 stages or more.
17. Energy recovery units.
18. Energy recovery wheels.
19. Expansion tanks.
20. Fan-coil units.
21. Fans and fan curves.
22. Filters and frames.
23. Finned tube radiation.
24. Fire dampers, including static pressure drop for each damper.
25. Flexible ductwork.
26. Flow measuring elements.
27. Grilles, registers and diffusers, including performance data.

28. HVAC equipment room drawings, with dimensions and elevations, showing equipment, coil and tube pull areas, sheet metal work and piping with locations of valves, thermometers, thermometer wells, gauges and needle valves, minimum 1/4" = 1'-0" scale.
29. Piping system drawings, showing equipment, piping, fittings, elevations, dimensions, valves, sleeves and accessories, coordinated with ductwork, building conditions, and other trades, minimum 1/4" = 1'-0" scale.
30. Precision air conditioning units.
31. Pumps and pump curves.
32. Rooftop air conditioning units.
33. Sheet metal system drawings indicating sizes, liner locations and static pressure class, showing air distribution equipment, including required clearances around control panels, coils, filters, return air openings, and other components, ductwork, fittings, dampers, ductwork access panels plenums, elevations, dimensions, offsets, and transitions coordinated with piping, building conditions, and other trades, minimum 1/4" = 1'-0" scale.
34. Smoke dampers, including static pressure drop for each damper.
35. Sound attenuators including certified laboratory data on dynamic insertion loss, airflow generated noise and airflow performance.
36. Split system air conditioning units.
37. Terminal units.
38. Unit heaters.
39. Valves, and strainers.
40. Variable frequency drives, including harmonic analysis study and report.
41. Water storage tanks.

1.8 EQUIPMENT AND INSTALLATION REQUIREMENTS

- A. Equipment and materials shall, unless otherwise specified herein, be new and shall be of the customary standard and quality furnished by the designated manufacturer for that catalogue number.
- B. Materials and equipment shall be UL listed, and shall bear the UL listing mark on products for which standards have been established and for which listing is regularly furnished by UL.
 1. In lieu of the UL listing, or where standards have not been established by UL and UL listing is not regularly furnished, materials and equipment shall be listed by a laboratory recognized under the OSHA Nationally Recognized Testing Laboratory Program or by a laboratory accredited by International Accreditation Service. Examples include:
 - a. Canadian Standard Association.
 - b. ETL Testing Laboratories, Inc.
 - c. MET Electrical Testing Company, Inc.
- C. Mechanical equipment that is not covered by NAECA-2015 shall carry a permanent label installed by the manufacturer stating that the equipment complies with the requirements of ASHRAE/IES 90.1-2019.

PART 2 - PRODUCTS

2.1 HANGERS AND SUPPORTS

- A. Hangers:
 1. General: complete with rods and supports proportioned to the size of piping or equipment to be supported.
 2. For steel pipe: steel or malleable iron, unless specified otherwise herein.
 3. For copper piping 4" and smaller: copper-plated; Anvil CT-69, B-Line B3170 CT, or ERICO 101.
 4. For black steel piping 2" and smaller: Anvil 69, B-Line 200, or ERICO 115.

5. For chilled water piping 3" and larger, and piping insulated to prevent sweating: galvanized; Anvil 260, B-Line B3100, or ERICO 401.

B. Hanger Rods:

1. One-piece steel type, threaded as required.
2. Sizes, unless specified otherwise herein, shall be as follows:

<u>Pipe Size</u>	<u>Rod Diameter</u>
2" and smaller	0.375"
2.5" and 3"	0.5"
4"	0.625"

3. Sizes for gang or multiple hangers: calculated for the combined weight of the piping and accessories.
4. Sizes for equipment hangers: calculated for the weight of the equipment supported.

C. Inserts:

1. Adjustable type: Anvil 282, B-Line B3014, or ERICO 355.
2. Continuous type: Anvil PS-5000, B-Line B32I, or ERICO CON.

D. Expansion Anchors:

1. In concrete: wedge, self-drilling, or drilled flush type.
2. In masonry: sleeve type.
3. Manufacturer: Hilti, ITW Ramset/Red Head, or Rawl.

E. Clamps for piping in bar joist construction: Anvil 92 or 93, B-Line B3031 or B3033, or ERICO 300.

F. Insulation protectors: Anvil 167, B-Line B3151, or ERICO 125.

G. Channel strut systems: 14 gauge minimum galvanized steel, with factory-punched attachment holes. Straps shall be designed so that the attachment nut is captive on the shoulder of the strap when tightened. Attachment nuts shall be designed to provide a surface on the turned down edge while making positive contact with the side walls of the channel. Nuts, bolts, straps, and accessories shall be protected with same finish as channels.

1. Manufacturer: B-Line, Kindorf, Midland-Ross, or Unistrut.

H. Pipe Stand Supports:

1. For chilled water piping: adjustable pipe saddles, stanchion type with locknut nipple, reducer, flange and baseplate. Provide U-bolt yoke for pipe 12" and smaller.
 - a. Manufacturer: Anvil 264, B-Line B3093, or ERICO 723 for pipe over 12".
 - b. Manufacturer: Anvil 265, B-Line B3092, or ERICO 724 for pipe 12" and smaller.

2.2 VALVE TAGS

- A. Minimum 19 gauge polished brass, 1.5" minimum size. Tags shall be square. Stamped numbers and letters shall be not less than 0.75" high, and filled with black paint.

2.3 IDENTIFICATION MATERIALS

- A. Pipe identification shall be 5 mil thick, self-adhering vinyl plastic tape. Tape and legend shall be as follows:

<u>Diameter (Including Insulation)</u>	<u>Width</u>	<u>Size of Legend Letters</u>
0.75 - 1.25"	8"	0.5"
1.5 - 2"	8"	0.75"
2.5 - 6"	12"	1.25"
8 - 10"	24"	2.5"
Over 10"	32"	3.5"

1. Legends shall be in full or abbreviated form, in contrasting color to background color.

- B. Nameplates and signs: laminated plastic, engraved with white letters. Background color shall be:

<u>System</u>	<u>Color</u>
Equipment served by emergency power	Red
Other equipment	Black

- C. Duct identification shall be strap-on type vinyl markers, minimum size 32" x 6" with minimum 3.5" lettering.

2.4 SLEEVES

- A. Sleeves shall be standard weight steel pipe except sleeves for concealed piping through floors not in structural members, and through interior drywall construction may be formed from 26 gauge galvanized sheet metal lapped and pop riveted.

2.5 PENETRATION SEALS

- A. Firestops:

1. Refer to Section Joint Firestopping 078443

- B. Expansion Seals:

1. Waterproof, modular, mechanical expansion type consisting of synthetic rubber grommets or interlocking links shaped to continuously fill the annular space between the penetrating item and the opening. Sizing of links and sleeve shall be determined by the manufacturer.
2. Manufacturer: Calpico Pipe Linx, Metraflex MetraSeal, or Thunderline Link Seal.

2.6 MOTORS

- A. General:

1. Motors shall be dripproof, unless otherwise specified herein or indicated on the Drawings, and in compliance with NEMA MG 1-2016 (R2018). Refer to Electrical Drawings for exact characteristics of motors. Dripproof and totally enclosed fan-cooled motors shall be rated on a 50°C and 55°C temperature rise basis, respectively, unless otherwise specified herein.
2. Dripproof and totally enclosed: 1800 rpm, induction type with a 1.15 service factor, unless otherwise specified herein.
3. Motors indicated on the Drawings as being controlled by variable frequency drives shall be:

- a. Designed in accordance with Part 31 of NEMA MG 1-2016 (R2018) for use with variable frequency drives.
 - b. Provide with factory-installed shaft grounding rings, which shall consist of a circumferential ring of conductive microfibers that discharge shaft voltages to ground.
 - 1) Manufacturer: AEGIS SGR.
4. Motors not furnished with equipment shall be by: Baldor, Century, Delco, GE, Marathon, Reliance, or Siemens.

2.7 STARTERS

A. General:

1. Manual reset, Class 20, thermal type overload protection for each phase, in accordance with NEMA ICS 2-2000 (R2005).
2. NEMA 3R enclosures for exterior application.
3. Equipment furnished with factory-installed starters shall also be equipped with individual motor disconnect and thermal magnetic circuit breakers or fuses as specified herein with lugs sized to receive a feeder as indicated on the Electrical Drawings.
4. 120 V secondary control power transformer with fused primary and secondary circuit in the enclosure.
5. Starters and contactors not furnished with equipment shall be provided by: ABB, Allen-Bradley, Crouse-Hinds, Cutler-Hammer, GE, Square D, Furnas, or Joslyn Clark, or Siemens-ITE.

B. For 3-phase motors, unless otherwise specified herein:

1. Combination magnetic type and fused disconnect switch with:
 - a. Fuses having type and UL class rating as specified in Division 26, providing Type 2 protection.
 - b. External operating handle capable of being locked in the off or open position.
 - c. Hand-off-automatic switch on the face for each fan and pump, except those manually controlled.

C. For 1-phase, unless otherwise specified herein:

1. Manual starting switch with thermal overload protection and pilot light.
2. Hand-off-automatic switch, except for manually controlled equipment.

2.8 VARIABLE FREQUENCY DRIVES

A. Variable frequency AC motor controllers shall be designed for use with new motors as specified in Paragraph 2.6, Motors.

B. Controllers:

1. NEMA 3R enclosure, wall- or floor-mounted, UL 508C-2016 listed, with integral power disconnect with door interlock, completely factory-wired, ready for field connection of incoming and outgoing power, and control signal, in compliance with NEMA ICS 1-2000 (R2005, R2008, R2015), NEMA ICS 6-1993 (R2001, R2006, R2011, R2016), and NEMA ICS 7.1-2014. Drives shall be rated a minimum of 100,000 A RMS symmetrical AIC.
2. Controllers shall be of the pulse width modulation type, and shall have the following features and functions contained in the cabinets unless otherwise specified herein:
 - a. Current limiting fuses or semi-conductor protection on the incoming line side.
 - b. Speed regulation within 3% accuracy.

- c. Serial communications capability for transmitting operating data and receive commands through a single connection to the building control system. Provide hardware and software for BACnet, LonWorks, or Modbus communication, as coordinated with building control system supplier.
- d. Interface connections for remote controls shall be wired to terminal strips as follows:
 - 1) Dry contacts for remote enable/disable.
 - 2) Process transducers for 4-20 mA speed adjustment signal.
 - 3) Terminals for connection of normally closed remote safety devices.
 - 4) Dry contact for external alarm, to open on internal drive fault, power supply fault, process transducer signal fault, or operation of remote safety devices.
- e. Harmonic Distortion Control:
 - 1) The variable frequency drive manufacturer shall perform a harmonic analysis study in accordance with IEEE 399-1997. The study shall establish the requirements for harmonic distortion control. Harmonic analysis study report shall be submitted concurrently with the variable frequency drive submittals and shall include variable frequency drives factory-installed on equipment, such as chillers.
 - 2) Variable frequency drive design shall be such that the maximum contribution from all variable frequency drives does not exceed the following:
 - a) IEEE 519-2014 voltage and current distortion limits at the point of common coupling.
- 3. Where specified herein, controllers shall be provided with damped low pass DV/DT drive output filters. Filters shall have K-rated line reactor, gapped iron core, inductor, copper windings and 40°C ambient temperature rating with a 155°C maximum operating temperature. Filters shall allow mounting of variable frequency drives up to 3000' from motor loads by filtering voltage spikes.
- 4. Controllers shall have the following internal protective functions for the protection of the controller modules and motors:
 - a. DV/DT (voltage transient) and DI/DT (short circuit) protection.
 - b. Inverse time overcurrent protection.
 - c. Full time current limit to limit maximum speed for prevention of overload.
 - d. Phase sequence (if phase sensitive), phase loss, overvoltage, undervoltage, electronic thermal overload, abnormal temperature, DC overvoltage, and internal fault protection.
 - e. Motor winding ground fault.
 - f. Motor and variable frequency drive overtemperature protection.
 - g. Input power line surge protective device.
- 5. Integral EMI/RFI filter. Controllers shall be designed to avoid RF interference with other electronic equipment internal or external to the building.
- 6. Diagnostic module shall identify faults as they occur, storing them in nonvolatile memory for recall, including:
 - a. Overcurrent.
 - b. Overvoltage.
 - c. Undervoltage.
 - d. Ground fault.
 - e. Electronic motor overload, UL listed for this function.
- 7. Operator panels shall include digital display and keyboard for entry of set-up parameters, recall of faults from diagnostic module, and display of current operating values including:
 - a. Output frequency.
 - b. Motor speed.
 - c. Motor current.
 - d. Output voltage.
 - e. Analog input values.

- f. Digital input status.
 - g. Elapsed time meter.
 - h. Power on indication.
 - 8. Provide nameplate engraved with system identification and hand-off-automatic switch. The hand position shall start the drive and shall have a manual means of speed adjustment. In the automatic position, the drive shall be started and adjusted remotely.
 - 9. Controller design shall permit operation at full load with ambient conditions between 0°C and 40°C, with capacity to handle 110% overload torque for 1 minute. Printed circuit boards shall be tested under full rated load at 10°C above rated ambient temperature for at least 20 hours, and failures corrected prior to shipment.
 - 10. When enabled by remote controls, controller shall start at zero speed and ramp to the current speed setting. Speed range shall be adjustable between 0 Hz and 66 Hz, with separately adjustable maximum and minimum speeds, and adjustable rate of acceleration and deceleration. Provide at least 2 lockout speed ranges with adjustable minimum and maximum speed settings to prevent operation at driven equipment resonant vibration frequencies.
 - 11. Controllers shall restart automatically upon restoration of stable electric service after power supply faults, with adjustable time delay before restart. Operating parameters shall be stored in nonvolatile memory. Controllers shall continue to operate at the minimum speed setpoint on loss of remote control signal, and activate the remote alarm contact.
 - 12. Variable frequency drives shall be designed for starting into a spinning motor. The variable frequency drive shall be able to determine the motor speed in any direction and resume operation without tripping. If the motor is spinning in the reverse direction, the variable frequency drive shall start into the motor in the reverse direction, bring the motor to a controlled stop, and then accelerate the motor to the preset speed.
 - 13. Drive displacement power factor shall be between 0.95 and 1.0 lagging over the entire operating speed range.
 - 14. Drive efficiency shall be greater than 96% at 100% speed full load.
- C. Start-up service: as specified in Section 230090, HVAC Performance Verification.
- D. Service: manufacturer shall maintain a parts and service facility within 8 hours of this Project, which shall have inventory to cover not less than 80% parts service within 24 hours, and 95% within 48 hours. Further, the facility shall have a factory-trained service representative to furnish installation, test, and start-up supervision necessary for final approval and acceptance, as well as to perform maintenance and repairs on components.
- E. Warranty: in addition to other warranties specified herein, equipment shall be guaranteed against defective parts and workmanship under terms of the manufacturer's standard warranty, but in no event shall it be for a period of less than 2 years from date of initial start-up of the system and shall include labor and travel time.
- F. Manufacturer: ABB, AC Tech, Allen-Bradley, Baldor, Danfoss, Eaton, Emerson, Fuji, GE, Hitachi, Johnson Controls/York, Siemens, Square D, Toshiba, Trane, US Drives, or Yaskawa.
- 2.9 VIBRATION ISOLATION
- A. Apparatus shall be by one manufacturer, except where herein specified otherwise.
- B. Where isolators are exposed to weather, springs shall be powder- or neoprene-coated and other parts hot-dipped galvanized or zinc-plated.
- C. Isolators:

1. Type FS - Free-standing, laterally stable, unhoused spring type with leveling bolts for bolting to the equipment. Spring diameter shall be not less than 0.8 of the compressed height of the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Springs shall be complete with neoprene or fiberglass noise isolation pads, minimum 0.25" thick, bonded to the baseplate.
 - a. Manufacturer: Kinetics Noise Control FDS, Mason SLF, Vibration Eliminator OST, VMC Group AW/AWH, or Vibro-Acoustics FS.
2. Type LS - Type FS isolators with addition of vertically restraining limit stops, and welded steel housings. Minimum clearance around the restraining bolts and between the housing and the spring shall be 0.5". Limit stops shall be out of contact with the housing during normal operation.
 - a. Manufacturer: Kinetics Noise Control FLS, Mason SLR, Vibration Eliminator KW, VMC Group M, or Vibro-Acoustics CSR.
3. Type DN - Double-deflection neoprene type, with neoprene-coated metal surfaces, and top and bottom surfaces ribbed. Isolators shall have bolt holes in the base.
 - a. Manufacturer: Kinetics Noise Control RD, Mason ND, Vibration Eliminator T44 or D44, VMC Group RD or RVD, or Vibro-Acoustics RD.
4. Type SH - Combination type hanger with steel spring and double-deflection neoprene or natural rubber element in series. The neoprene or natural rubber element shall have a minimum static deflection of 0.35". Spring diameter shall be not less than 0.8 of the compressed height of the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Hangers shall be designed for a minimum of 15° angular misalignment from vertical before rod contacts housing.
 - a. Manufacturer: Kinetics Noise Control SRH, Mason 30N, Vibration Eliminator SNRC, VMC Group HRSA, or Vibro-Acoustics SHR.
5. Type PSH - Type SH isolators precompressed to the rated deflection. Hangers shall have a release mechanism to free the spring after installation is complete.
 - a. Manufacturer: Kinetics Noise Control SFH, Mason PC 30N, Vibration Eliminator PCSR, VMC Group HRSA-PR, or Vibro-Acoustics PSHR.
6. Type NH - Double-deflection neoprene or natural rubber hanger type, with neoprene or natural rubber grommet between hanger rod and housing. Neoprene or natural rubber element shall have neoprene- or natural rubber-coated metal surfaces.
 - a. Manufacturer: Kinetics Noise Control RH, Mason HD, Vibration Eliminator C, VMC Group HR, or Vibro-Acoustics NH.
7. Type NS - Sandwich pad type, with minimum 0.25" thick ribbed or waffled neoprene pad bonded to each side of 16 gauge plate. Isolator pads shall be selected for less than 80% maximum rated load.
 - a. Manufacturer: Kinetics Noise Control RSP, Mason WSW, Vibration Eliminator P, VMC Group Multi-Layer Shear-Flex, or Vibro-Acoustics 400 NP.
8. Type NP - Neoprene pad type, minimum 0.25" thick ribbed or waffled on both sides. Isolator pads shall be selected for less than 80% maximum rated load.
 - a. Manufacturer: Kinetics Noise Control NP, Mason W, Vibration Eliminator N, VMC Group Shear-Flex, or Vibro-Acoustics N.
9. Type NR - Isolator anchor type consisting of a telescopic arrangement of two sizes of steel tubing separated by a minimum 0.5" thick heavy duty neoprene and duck or neoprene isolation material. Vertical restraints shall be provided by similar materials arranged to prevent vertical travel in either direction. Allowable loads on the isolation material shall not exceed 500 psi and the design shall be balanced for equal resistance in any direction.

- a. Manufacturer: Mason ADA, or VMC Group AG.
- 10. Type PI - Piping isolator type, 30 durometer ribbed neoprene ring, inside diameter sized for piping outside diameter, and mounting bracket.
 - a. Manufacturer: Specialty Products Company, or Stock Drive Products.
- 11. Type SR - Rail type, consisting of a set of structural steel beam, aluminum channel or angle rails to which Type FS DN isolators are rigidly attached. Bolt holes shall be provided for bolting equipment to the rails. Rail deflection shall be limited to less than 1/360 of unsupported span. Wind and uplift restraints shall be provided as required for exterior installations.
 - a. Manufacturer: Kinetics Noise Control SFB, Mason M, or WF, VMC Group SR, DRB, or Vibro-Acoustics IFB.
- 12. Type SC - Curb type, with integral isolators, designed to fit over the roof curb and under the isolated equipment. The extruded aluminum top and bottom members shall contain cadmium-plated springs having a 1" minimum deflection with 50% additional travel to solid. Spring diameter shall be not less than 0.8 of the compressed height of the spring. Springs shall be provided with positive spring retainers with flexible ties to maintain base integrity during shipping and rigging. Wind resistance shall be provided by means of resilient snubbers in the corners with a minimum clearance of 0.25" so as not to interfere with the spring action except in high winds. The weather seal shall consist of continuous closed cell sponge materials both above and below the base and a waterproof, frictionless, flexible neoprene connection joining the outside perimeter of the extruded aluminum members. Upper and lower extruded aluminum members shall have heliarc welded, mitered corners.
 - a. Manufacturer: Kinetics Noise Control KSR, Mason RSC, Vibration Eliminator AR, VMC Group RTIR, or Vibro-Acoustics RTR.
- 13. Type SCH - Curb type, with integral isolators, designed for the roof structure and equipment to be isolated. Lower members shall be rectangular steel tubes with provisions for accommodating roof slope and maintaining equipment level. Upper frame shall provide continuous support for the equipment and shall resiliently withstand wind and seismic forces. Directional snubber bushings shall be minimum 0.25" thick neoprene. Steel springs isolating the upper frame shall be stable unhoused type with a minimum static deflection of 2" 3" with 50% additional travel to solid. Springs shall be adjustable and removable, and shall be mounted on 0.25" thick neoprene pads. Hardware shall be cadmium-plated or galvanized, and springs shall have a corrosion resistant finish. Weather seal shall consist of a continuous closed cell sponge material on top of the curb and a waterproof flexible aluminum seal joined at the corners by EPDM bellows. Lower portion of curb shall be insulated, and curb shall have provisions for flashing and counter flashing.
 - a. Manufacturer: Kinetics Noise Control KSCR or ESR, Mason SRSC, Vibration Eliminator VERC, VMC Group P, or Vibro-Acoustics VCR.
 - b. Manufacturer: Mason MT.
- D. Flexible elastomeric pipe connectors: twin-sphere type, made of multiple plies of nylon cord fabric and neoprene, hydraulically molded. Connectors through 1.5" shall have threaded ends, and connectors 2" and larger shall have flanges with recessed groove to receive the connector's raised neoprene face. Connectors 4" and larger operating above 100 psig shall have isolated limit stops to prevent overextension and overcompression. Limit stops shall be either control cables with neoprene isolated end fittings and anti-compression stops, or spring-loaded control units. Connectors shall be line size and shall be designed for the pressures and temperatures encountered in the system, minimum 150 psig and 220°F.
 - 1. Manufacturer: Kinetics Noise Control KinFlex, Mason Safeflex, VMC Group 2600 or 2655, or Vibro-Acoustics EJE2 or EJN2.
- E. Flexible metal hose connectors: stainless steel corrugated type with stainless steel woven braid outer sheath.
 - 1. Manufacturer: Kinetics Noise Control BFMC, Mason BSS, VMC Group SS, Vibration Eliminator Stainless Steel Flexible Connectors, or Vibro-Acoustics FCSS.

- F. Thrust restraints: a set (2 or more) of spring thrust resisting assemblies consisting of coil springs, spring retainers, isolation washers, angle mounting brackets, and elastomeric tubing for isolating thrust rods.
 - 1. Manufacturer: Kinetics Noise Control HSR, Mason WB, Vibration Eliminator HTR-1, VMC Group TRK, or Vibro-Acoustics AHCS.
- G. Caulking: resilient, paintable, nonsag and nonhardening latex sealant complying with ASTM C834-2017.
 - 1. Manufacturer: Hilti Smoke & Acoustic Sealant CP506, Owens Corning Quietzone Acoustical Sealant, 3M FireDam 150+, STI SpecSeal Smoke 'N' Sound Sealant, or U.S. Gypsum Firecode Smoke-Sound Sealant.

2.10 SEISMIC AND WIND RESTRAINTS

- A. Seismic force design shall be determined in accordance with the following seismic design criteria:
 - 1. Office Tower
 - 2. Seismic Design Category: C
 - 3. Risk Category: II.
 - 4. Component Importance Factor, I_p : 1.0.
 - 5. E.O.C. Building
 - 6. Seismic Design Category: D.
 - 7. Risk Category: IV.
 - 8. Component Importance Factor, I_p : 1.5.
- B. Provide restraint devices as required for vibration isolated and non-vibration isolated mechanical components. Provide calculations to determine restraint loadings for specific components to be installed resulting from seismic forces on components. Seismic restraint calculations shall be signed by a licensed engineer in the employ of the seismic restraint device manufacturer.
- C. For roof-mounted equipment and components both the seismic acceleration and wind loads shall be calculated, and the highest load shall be utilized for the design of the seismic restraints and vibration isolators.
- D. Exceptions for HVAC components listed within the applicable project building code may be utilized. However, use of exceptions shall be noted with submitted seismic restraint calculations.
- E. Seismic restraints and vibration isolators provided with integral seismic restraint capacity shall have Anchorage Preapproval "R" Number from OSHPD in the State of California listing minimum certified horizontal and vertical load ratings.
- F. Floor-Mounted Restraints:
 - 1. All-directional external seismic restraints for floor-mounted components shall consist of interlocking steel assemblies restrained when engaged under seismic motion by elastomeric material with a minimum thickness of 0.25". The minimum air gap between interlocking assemblies shall be 0.125".
 - 2. Restraints for neoprene vibration isolators shall consist of Type DN isolators with the addition of welded steel housings to resist seismic forces.
 - 3. Restraints for free-standing floor springs shall consist of Type FS isolators with the addition of welded steel housings to resist seismic forces. Restraints shall allow a maximum movement of 0.25" in all directions.
 - 4. Manufacturer: Kinetics Noise Control, Mason Industries, VMC Group, Vibration Eliminator, or Vibro-Acoustics.
- G. Suspended Restraints:

1. Restraints for vibration isolated suspended equipment and components shall consist of galvanized or stainless steel aircraft cables with end connection fittings designed to swivel in order to ensure proper cable alignment and avoid bending of cable.
2. Restraints for non-vibration isolated suspended equipment and components shall consist of steel angle or unistrut with anchor bolts and end connection fittings designed to swivel to the final installation angle.
3. Manufacturer: B-Line, International Seismic Application Technology, Kinetics Noise Control, Mason Industries, Tolco, VMC Group, Vibration Eliminator, or Vibro-Acoustics.

2.11 CONCRETE

- A. Normal weight concrete (145 pcf) using Type I Portland Cement, 1" maximum size coarse aggregate to provide a minimum 28 day compressive strength of 3000 psi.

2.12 GROUT

- A. Nonshrink type, conforming to ASTM C1107/C1107M-2017 when tested at fluid consistency. Grout shall exhibit zero bleeding at every age when mixed to fluid consistency. Minimum 28 day compressive strength, when mixed to fluid consistency, shall be 7000 psi.
- B. Manufacturer: Cormix, or Master Builders.

2.13 ACCESS PANELS - BUILDING

- A. Refer to Section 083113, Access Door Panels.

2.14 ESCUTCHEONS

- A. Split hinged type, constructed of chromium-plated steel or cast brass, sized to fit over insulation and to cover sleeve.

2.15 UNDERGROUND WARNING TAPE

- A. Tape shall be acid- and alkali-resistant polyethylene film tape, 6" wide with minimum thickness of 0.004", specifically designed for marking and locating of underground utilities.
- B. Tape shall be manufactured with integral wires, foil backing or other means to enable detection by a metal detector when the tape is buried up to 3' deep. The metallic core of the tape shall be encased in a protective jacket or provided with other means of corrosion protection.
- C. Tape color shall be as specified below and shall bear a continuous printed inscription describing the specific utility:

<u>Utility</u>	<u>Color</u>
Chilled water	Blue

- D. Manufacturer: Brady, Boddingtons, Carlton Industries, Seton, or Thor Enterprises.

2.16 PAINTING

- A. Paint for high temperature piping and equipment shall be high temperature resistant, designed for the temperatures at which the system will operate.

PART 3 - EXECUTION

3.1 PROTECTION OF EQUIPMENT AND MATERIALS DURING CONSTRUCTION

- A. Provide protective covers, skids, plugs or caps to protect equipment and materials from damage or deterioration during construction.
- B. Store equipment and material under cover, and off the ground or floors exposed to rain.
- C. For outdoor storage, protective covers of 10 mil thick black sheet plastic shall be fitted over equipment and materials. Covers shall be reinforced to withstand wind and precipitation. Set equipment and material on skids or platforms of height to avoid damage or deterioration from spattering and ground water.
- D. Protect coils against damage by installing temporary closure panels over exposed coil faces. Panels shall be minimum 24 gauge sheet metal or 0.375" plywood.
- E. Close open ends of fans, terminal units, air handling units, and ductwork with temporary closures of sheet plastic taped in place.
- F. Plug ends of pipes when work is stopped to prevent debris from entering the pipes.
- G. Provide dust and debris protection for ductwork, coils, fans, equipment, motors, and bearings operated during construction up to date of substantial completion.
- H. Cover open ends of exhaust and return ducts with temporary filter media while fan systems are operating.

3.2 EQUIPMENT AND INSTALLATION REQUIREMENTS

- A. Air systems shall operate without aerodynamic noise generated from the faulty installation of ductwork or any component of the air distribution system.
- B. Equipment shall be installed and connected as specified herein or indicated on the Drawings in accordance with the manufacturers' instructions and recommendations for this Project. Furnish and install auxiliary piping, water seals, valves, and electrical connections recommended by the manufacturer for operation.
- C. Motor quantities, sizes and equipment wattage ratings specified herein or indicated on the Drawings are the minimum requirements, unless noted otherwise. Motor quantities, sizes and equipment wattage ratings less than those specified herein or indicated on the Drawings are not acceptable. Larger motor sizes and equipment wattage ratings may only be provided if necessary to meet the prescriptive requirements specified herein or indicated on the Drawings. Where multiple motors or motor sizes or equipment wattage ratings larger than specified herein or indicated on the Drawings are furnished, provide and coordinate the corresponding increased number or capacity of feeders and other electrical equipment serving them, at no additional cost to the Owner.
- D. Fans, drive sheaves, motors, and pumps shall be statically and dynamically balanced and shall have steady state radial vibration levels which do not exceed the following:

<u>Equipment</u>	<u>Peak-to-Peak Displacement (mils)</u>
Fans, drive sheaves, and motors	
under 600 rpm	4
600 to 1000 rpm	3
1000 to 2000 rpm	2
over 2000 rpm	1
Pumps and motors	
over 1800 rpm	1
under 1800 rpm	2

- E. Field-installed equipment controls or sensor wiring shall be installed in conduit. Low voltage control and sensor wiring shall be installed in conduits separate from line voltage control wiring and power wiring.
- F. Where connection sizes at equipment vary from the pipe size indicated on the Drawings, provide appropriate reducers/increasers directly adjacent to the pipe-equipment unions. Unless otherwise specified herein or indicated on the Drawings, the size of the valves and accessories dedicated to the equipment shall not be less than the pipe size to which they are connected.

3.3 HANGERS AND SUPPORTS

- A. Where several pipes run parallel and in the same plane:
 - 1. 2.5" and smaller: may be supported on gang or multiple hangers. Separate copper tubing from ferrous supports with copper-plated steel or 4 psf sheet lead.
 - 2. 3" and larger: support independently, parallel, and equally spaced.
- B. Supports for steel pipe and for copper tubing shall not be more than 10' apart. Supports for copper tubing 1.25" and smaller shall be not more than 5' apart. Pipes shall be supported within 1' of each elbow and tee, and for piping 2.5" and larger at each valve and strainer or each close-coupled group of valves, traps, and strainers.
- C. Install a 4 psf lead saddle at each hanger on uninsulated copper piping 4" and larger.
- D. Hangers and supports for insulated piping shall bear on outside of insulation. Hangers shall be sized for uncompressed insulation thickness.
- E. Provide insulation protectors.
- F. Support vertical chilled water, piping on every floor, unless otherwise specified herein or indicated on the Drawings.
- G. Support piping independently of equipment.
- H. Adjust hangers and supports so that loading is uniform.
- I. Hanger rods shall be suspended from the structure. Do not suspend from other piping, equipment, or ductwork.
- J. Inserts:
 - 1. Use for piping 2.5" and larger in new concrete construction.
 - 2. Where the weight to be supported by an insert exceeds 50% of its rated load, install 2 No. 3 reinforcing rods, 3' long through each yoke of insert.

K. Expansion Anchors:

1. Use for piping in existing concrete and masonry construction.
2. Use for piping 2" and smaller in new concrete construction.

L. Where indicated on the Drawings, support piping on pipe stand supports. At the base of each support, weld a slip-on flange to the vertical stanchion. Place stanchion and flange on top of a baseplate, welding the flange to the baseplate. Anchor baseplates to vibration isolators or foundations. Provide schedule 40 pipe to increase stanchion height as required by field conditions.

3.4 SLEEVES

A. Provide where pipes pass through walls, floors and roofs, except in the following circumstances:

1. Concealed wall openings of the required diameter in non fire- or smoke-rated construction, unless specified herein to have voids packed with fiberglass and caulking.
2. Concealed floor openings formed by the use of plastic forming devices providing a circular opening of the required diameter.
3. Core drilled concealed openings. Openings in roofs shall not be core drilled. Obtain written permission prior to core drilling.
4. Openings in concrete floor slabs on grade.

B. Sleeves shall be placed into position prior to wall, floor, or roof construction. Sleeves shall be tight-fitting and cut smooth.

C. Floor sleeves shall be cast in place, shall be watertight, and shall extend from the bottom of the slab to 2" above the finished floor.

D. Wall sleeves shall extend 1" on each side of walls.

E. Make sleeves through outside walls above and below grade watertight.

F. Size sleeves for insulated pipes penetrating nonrated construction to allow full thickness insulation.

G. Sleeves in nonrated construction shall be sized to provide clearance all around pipe, including insulation, to accommodate thermal movement. Clearance shall be minimum 0.75".

H. Furnish 4 psf lead flashing for sleeves through flat built-up roofs extending at least 8" from the sleeve in all directions.

3.5 PENETRATION SEALS:

A. General:

1. Install in accordance with the manufacturer's published instructions to achieve ratings and classifications specified herein. A copy of these instructions shall be maintained and available on site.

B. Firestops:

1. Close and firestop penetrations through fire- and smoke-rated construction. Materials used to seal these penetrations shall continue the construction's fire and smoke resistance ratings uninterrupted and shall maintain an effective barrier against the spread of flame, smoke, water and hot gases. Install after installation of ductwork, piping, and conduits.

C. Exterior Wall Seals:

1. Piping without insulation: use expansion seals between pipes and sleeves. Where walls exceed the width of expansion seals, use two seals, one being flush with the inside sleeve face and the second with the outside sleeve face. Fill the annular void space between the two seals.
2. Piping with insulation: pack center annular space between the insulation and the sleeve with fiberglass, then caulk 1" deep from each face to the fiberglass with nonhardening sealant. Smooth sealant with face of sleeve.

3.6 IDENTIFICATION OF PIPING

- A. Identify piping specified under this Division in accordance with ASME A13.1-2015.
- B. Legends shall be on the lower quarters of the pipe except where such location would be obscured. Arrow tape shall be wrapped completely around the pipe at each end of the legend with arrows pointing in the direction of flow.
- C. Locate pipe identification as follows:
 1. In equipment rooms:
 - a. Within 18" of each valve or valve assembly.
 - b. Within 36" of each 90° elbow, connection to equipment or vessel, point where pipe enters shafts and pierces outside walls.
 - c. On not over 20' intervals along exposed piping.
 2. Above suspended ceilings:
 - a. Within 18" of each valve or valve assembly.
 - b. At tees within 36" of both main and branch.
 - c. Within 36" of each 90° elbow.
 - d. Identify at not less than 1 point each piping run visible in each room with identification on not over 20' intervals.
 3. Piping concealed in chases or shafts:
 - a. Each pipe visible through an access door or panel.
 4. Piping exposed in rooms other than mechanical equipment areas:
 - a. Omit identification of piping 0.5" and smaller exposed at connections to equipment.
 - b. With the above exception, identify at not less than 1 point each piping run visible in each room with identification on not over 20' intervals.
- D. Schedule of Piping Identification:

<u>Piping System and Contents</u>	<u>Tape Color</u>	<u>Legend</u>	<u>Abbreviated Legend</u>
Chilled Water	Green	Chilled Water	CHS & CHR

- E. Piping with temperature maintenance cable shall be labeled Electronically Traced on the outside of the insulation jacket.

3.7 VALVE TAGS AND SCHEDULES

- A. Provide numbered brass tags on valves except at unit heaters, fan-coil units, terminal unit coils, finned tube radiation, and convectors. Attach tags to valve stems with brass S-hooks or brass chain.

- B. Tags on new valves shall continue the numbering sequence of existing valves.
- C. Provide for each system a typewritten schedule of valves giving number, location (room number), and function of each with a small scale diagram outlining general piping layout and location of each numbered valves.

3.8 IDENTIFICATION OF EQUIPMENT

- A. Identify equipment, Identification shall consist of upper case letters.
- B. Each starter, variable frequency drive, contactor, push button station, control switch, disconnect, and thermal overload switch shall be appropriately identified by nameplates with 0.25" high letters.
 - 1. Identification shall include the equipment designation and device function, e.g., CT-1 Water Level Control Disable.
- C. Each piece of equipment and access door shall be stenciled with its equipment number in a prominent location with minimum 2" high letters.
- D. Access panels and doors in ductwork and plenums shall be stenciled with minimum 1" high letters to indicate the type of devices accessible therein and the system or fan identification number associated with that ductwork or plenum.
- E. Access panels in grease ductwork shall be labeled "Access Panel – Do Not Obstruct".
- F. Identify each filter using a stick-on tag with the filter size and description, the American Air Filter part number, and the quantity of filter units required. Tags shall be installed near or on the filter access door.

3.9 IDENTIFICATION OF DUCTWORK

- A. Markers shall be secured to ductwork with draw bands.
- B. Legends shall be on the underside of the duct except where such location would be obscured. Legends shall include name of air handling unit or fan system and arrows pointing in the direction of flow.
- C. Concealed ductwork shall be labeled with identification materials specified herein. Exposed ductwork shall be stenciled with minimum 3.5" uppercase letters.
- D. Supply ductwork downstream of terminal units shall not be labeled.
- E. Locate duct identification as follows:
 - 1. Mechanical Equipment Rooms:
 - a. Within 36" of each elbow, connection to equipment, and point where duct enters a shaft.
 - b. On not over 20' intervals along exposed ductwork.
 - 2. Above Suspended Ceilings:
 - a. Within 18" of each terminal unit.
 - b. At branch connections within 36" of both main and branch.
 - c. Within 36" of each elbow and point where duct enters a shaft.
 - d. On not over 40' intervals.
 - 3. Ductwork Concealed in Chases or Shafts:
 - a. Each duct visible through an access door or panel.

F. Schedule of Ductwork Identification:

<u>Duct System and Contents</u>	<u>Background Color</u>	<u>Legend</u>	<u>Legend Color</u>
Outside Air	Green	Outside Air	White
Supply Air	Blue	Supply Air	White
Return Air	Red	Return Air	White
Relief Air	Red	Relief Air	White
Toilet or Janitor Closet Exhaust	Yellow	Toilet Exhaust	White

3.10 MOTORS

- A. Provide motors for equipment covered in Division 23 unless otherwise specified herein. Select motors for operation not exceeding a 1.0 service factor and within the nameplate amperage and nominal power rating.

3.11 STARTERS

- A. Provide starters, push buttons, thermal overload switches, and contactors for equipment covered in Division 23 unless otherwise specified herein. Installation of starters, push buttons, and thermal overload switches, not factory installed, is specified under Division 26.
- B. Provide 120 V secondary control power transformers for control circuits where equipment is served at 208 V or higher.

3.12 FUSES

- A. Provide fuses in equipment furnished under this Division of the specifications.
- B. Provide 3 spare fuses of each size, UL class, and voltage rating furnished under this Division of the specifications and turn over to the Owner. Obtain a receipt for same.

3.13 VARIABLE FREQUENCY DRIVES

- A. Installation is specified under Division 26.
- B. Start-up shall be performed under the supervision of a technical service employee of the manufacturer. Set minimum speed at 20%, and calibrate the control input to match the operating conditions and the automatic temperature control system. Submit written certification, upon completion, that components have been installed correctly in accordance with the manufacturer's recommendations, are operating correctly, and that operation and set-up has been coordinated with the automatic temperature control systems.
- C. Test each fan from minimum to maximum speed to determine the resonant frequencies. Once the resonant speeds have been determined, adjust the frequency lock-out feature to eliminate fan operation at those speeds.
- D. Install DV/DT drive output filters where load lead length is 50' and greater.

3.14 VIBRATION ISOLATION

- A. General:

1. Select and locate vibration isolation equipment for uniform loading and deflection, according to weight distribution of equipment.
2. Vibration isolators shall be installed and connected as specified herein or indicated on the Drawings in accordance with the manufacturer's written instructions and certified submittal data.
3. Installation of vibration isolation equipment shall be supervised by an authorized, factory-trained manufacturer's representative.
4. There shall be no direct contact of isolated piping, ductwork, or equipment with shaft walls, floor slabs, structural elements, conduits, or any other nonisolated item.
5. Prior to startup, clean out foreign matter between bases, isolators, equipment, and mounting surfaces. Verify that there are no rigid connections between equipment and building structure.
6. Where recommended by the manufacturer, isolator baseplates shall be bolted to the structure or foundation. Bolting shall incorporate neoprene bushings and washers.
7. Installed Type FS isolators shall not incorporate a leveling bolt of greater length than that supplied with the isolators.
8. Isolator hangers shall be installed with housings a minimum of 2" below but as close to the structure as possible.
9. Absence of Type SR isolators scheduled on Drawings shall not preclude their use. Coordinate with the manufacturer if installation conditions warrant their use once specific equipment selection is finalized.
10. Vibration isolators shall not cause any change in position of equipment, piping, or ductwork resulting in stresses or misalignment.
11. Conflicts with other trades that will result in direct contact with isolated equipment, piping, or ductwork, shall be brought to the attention of the Architect prior to installation.
12. Discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection shall be brought to the attention of the Architect prior to installation.
13. After installation, manufacturer shall verify that vibration isolation systems are installed and operating properly, and shall submit a certificate so stating. Verify that isolators are adjusted, with springs perpendicular to bases or housing, adjustment bolts are tightened up on equipment mountings, and hangers are not cocked, and Type DN baseplates are bolted to foundations. In addition, manufacturer shall certify that Type **SC SCH** isolator curbs are assembled and installed properly.

B. Equipment Isolation:

1. Isolated equipment mounting systems shall permit equipment motion in all directions.
2. Mount fans, as indicated on the Drawings, on structural steel vibration bases common to both fan and motor.
3. Mount pumps and equipment, as indicated on the Drawings, on concrete-filled inertia bases. Inertia bases shall be arranged with spring isolator locations such that a horizontal plane passing through the top of the isolators will pass through or above the center of gravity of the equipment and base. There shall be a minimum operating clearance of 2" between each inertia base and its foundation.
4. Provide height saving brackets where recommended by the manufacturer for equipment stability, or operating height requirements.
5. Provide spring-loaded thrust restraints for fans and air handling units where movement under any operating condition will exceed 0.375".
6. Compressors for rooftop air conditioning units, penthouse air conditioning units, natatorium dehumidification units, and self-contained air conditioning units shall be isolated from the support structure with Type NP isolators.
7. If Type SC isolator curbs are not shipped to the site as one factory-fabricated unit, manufacturer shall provide an authorized representative to supervise field joining of sections (maximum of 2 joints per curb allowed).
8. Assemble, install and attach Type SCH isolator curbs in accordance with manufacturer's instructions. Manufacturer shall provide an authorized representative to supervise assembly and installation.
9. Engine-generator set silencers and associated piping shall be supported with Type SH isolators with a minimum 1.5" static deflection.

10. Steam pressure reducing valve assemblies shall be supported with Type SH isolators with a minimum 2" static deflection.
11. Type AS isolators shall be connected to the building control air supply system. served by a separate compressed air supply as specified herein.
12. Threads cut into compressed air galvanized pipe shall be painted with cold galvanizing compound.
13. Threads on compressed air fittings and bolts shall be fully engaged. Threads shall be made up using joint compound or Teflon tape.
14. Mount air compressor on Type NS isolators.

C. Piping Isolation:

1. Chilled Water Piping:

a. Horizontal:

- 1) Pipe stand supports shall be supported on Type LS isolators for the first 2 supports adjacent to the equipment and on Type FS isolators for the remaining isolated pipe length. Isolators shall have a minimum 1" static deflection.
- 2) Piping shall be suspended with Type PSH isolators for the first 3 hangers adjacent to the equipment. The remaining isolator hangers shall be Type SH. The first 3 hangers shall have the same minimum static deflection as the equipment isolators, with a maximum of 2". The remaining isolators shall have a minimum 1" static deflection.

b. Vertical:

- 1) Piping shall be isolated from the supporting members or structure with Type FS isolators with a minimum 1" static deflection.

D. Flexible Pipe Connections:

1. Provide at piping connections to equipment if the associated piping cannot be isolated as specified herein due to space limitations.
2. Install flexible metal hose with at least one 360° loop when the straight hose length between connections would be less than 5 times the hose diameter for air compressors and vacuum pumps.

E. Caulking: install in accordance with ASTM C919-2019.

3.15 EQUIPMENT AND EQUIPMENT ROOMS

- A. Remove dust, dirt, rust, stains, and temporary covers.
- B. Foreign matter shall be blown, vacuumed, flushed, or cleaned out of and from new equipment, piping, ductwork, pumps, fans, motors, bearings, devices, switches, controls, and panels.
- C. Clean and polish identification plates.
- D. In equipment rooms, clean equipment, ductwork, insulation, piping, conduit, and room surfaces from dust and dirt and maintain in a clean condition from date of substantial completion the Architect's final certificate until final completion of work and corrective work.
- E. Remove excess material from the Project site.

3.16 SEISMIC AND WIND RESTRAINTS

- A. Restraints shall be installed after the equipment is mounted, piped, connected, and operating to ensure that no contact occurs during normal equipment operation.

- B. Installation of seismic restraints shall not cause any change of position of equipment or components resulting in stress and misalignment.
- C. No rigid connections between equipment or components and the building structure shall be made that degrade the vibration isolated system specified herein.
- D. Equipment that is internally vibration isolated and restrained shall have its entire unit assembly seismically attached to the structure.
- E. Do not brace a system to two different structures, such as a wall and a ceiling.
- F. After installation, manufacturer shall verify that seismic and wind restraints are installed and operating properly, and shall submit a certificate so stating.

3.17 FOUNDATIONS

- A. Provide concrete foundations for the following floor-mounted equipment:

<u>Equipment</u>	<u>Foundation</u>
Pumps	4" high pad
Chillers	4" high pad
Chilled water buffer tanks	4" high pad
Air handling units	4" high pad

- 1. Foundation height shall accommodate seismic anchors, and condensate P-traps, but shall be not less than the minimum specified above.
- B. Foundations shall be continuous and shall have beveled edges and smooth float finish. Foundations shall be reinforced with No. 3 bars a maximum of 12" on center each way, and held in place with dowel rods at each corner anchored in the slab. Dowel rods shall not penetrate through the slab.
- C. Roughen and clean exposed slabs before pouring foundations. Apply bonding agent to surfaces in contact.
- D. Foundations shall extend a minimum of 6" beyond the equipment footprint or 1.5 times the seismic anchor embedment depth from the point of anchoring (whichever is larger) in all directions, including appurtenances, vibration isolators, base elbow supports, and motors.
- E. Equipment attached directly to foundations or inertia bases; bases provided with grout holes; and bases consisting of a structural frame shall have voids filled with grout after attachment to foundation.
- F. Fill voids between baseplates and foundations, and level equipment, with grout.

3.18 ACCESS PANELS - BUILDING

- A. Where HVAC work is concealed by walls or ceilings, or is inaccessible, provide an access panel to provide access for service and maintenance.
- B. HVAC work located above ceilings is considered accessible if the ceiling is the accessible type and is arranged for access to the equipment.

- C. Fire-rated access panels shall be provided in fire barriers with ratings to match the construction fire rating.
- D. Access doors providing access to ductwork access doors shall allow for service and maintenance of the intended equipment.
- E. Installation of access panels is specified under another Division.

3.19 ESCUTCHEONS

- A. Provide escutcheons where exposed piping passes through walls, floors and ceilings in finished areas.

3.20 UNDERGROUND WARNING TAPE

- A. During backfill, install tape continuously along length of piping, 12" to 18" above the piping for:
 - 1. Chilled water.

3.21 PAINTING

- A. Except where otherwise specified herein, painting shall be done under another Division. Surfaces shall be left clean and free from oil.
- B. Equipment factory finishes damaged or deteriorated during construction shall be repaired to match original finish.
- C. Where galvanizing is broken during fabrication or installation, recoat exposed areas with zinc-rich paint.
- D. Exterior ferrous equipment, piping and supports shall be painted with 2 coats of rust preventive paint, color selected by the Architect.
- E. Exposed interior uninsulated black steel piping, and exposed nongalvanized ferrous accessories, hangers, rods, inserts, and mechanical supports shall be prepared and painted with 1 coat of rust preventive paint prior to other painting or identification, or 2 coats of rust preventive paint if no other painting is specified.
- F. Ductwork, conduits, insulation, pipe and structure visible through architectural return air openings, grilles, registers and diffusers shall be painted flat black.

3.22 EXCAVATION AND BACKFILLING

- A. Install underground piping outside the building with 36" minimum cover, unless specified otherwise herein.
- B. Determine exact location of existing underground utilities before excavation.
- C. Excavations shall be no longer or deeper than necessary. Backfill material shall be free from rocks and debris.
- D. Compact backfill as the excavation is filled.
- E. Excavation, shoring, bracing, backfilling, and compaction shall conform to Division 31, Earthwork.

3.23 COORDINATION

- A. Provide offsets, transitions, and fittings to coordinate the work of each trade with that of other trades, including plumbing, fire protection, electrical, structural, and architectural.

3.24 OPERATION AND MAINTENANCE MANUALS

- A. These operation and maintenance manual requirements supplement operation and maintenance manual documentation requirements of other Sections of these specifications.
- B. Operation and maintenance documentation, in a bookmarked PDF document and in hardback 3-ring loose-leaf binders except full size drawings, shall cover the HVAC and automatic temperature control systems. Documentation shall include an operations and maintenance documentation directory, emergency information, operating manual, maintenance manual, test reports, and construction documents.
- C. The operation and maintenance documentation package shall be submitted as one comprehensive package to the Architect 3 months before systems start-up, and shall be updated, revised and completed at completion of construction.
- D. Compile and coordinate the documentation for equipment and systems installed. Documentation shall be typewritten and shall contain, at a minimum, the following information.
 - 1. Introduction:
 - a. Project name, contractors' and subcontractors' names, addresses, and telephone and facsimile numbers. Indicate the portion of the work for which each subcontractor was responsible.
 - b. Index.
 - 2. Operation and Maintenance Documentation Directory:
 - a. Explanation of the identification system used, including lists of systems, equipment, and component identifiers and names.
 - 3. Emergency Information:
 - a. Information for technical and nontechnical personnel about actions recommended during emergency situations to protect life and property and to minimize disruption to the building occupants. Emergencies shall, at a minimum, include:
 - 1) Fire.
 - 2) Water outage.
 - 3) Power failure.
 - 4) Heating failure.
 - 5) Cooling failure.
 - 4. Operation Manual:
 - a. General Information:
 - 1) Building function.
 - 2) Building description.
 - 3) Operating standards and logs.
 - b. Technical Information:
 - 1) System description.
 - 2) Operating routines and procedures.
 - 3) Seasonal start-up and shutdown.
 - 4) Special procedures.
 - 5) Basic troubleshooting.

5. Maintenance Manual:
 - a. Descriptions (specifications) of the equipment and components.
 - b. Description of function, as applicable: the function of the equipment, procedures before start-up, functional parameters (input, output) at the design load and at part loads, and performance verification procedures.
 - c. Recommended maintenance and lubrication procedures and their recommended frequency for this Project.
 - d. Recommended list of spare parts, part numbers, and the place(s) from which they can be obtained.
 - e. Original purchase order number; date of purchase; name, address, and the telephone number of the vendor; and warranty information.
 - f. Name and address of at least one service agency capable of providing maintenance.
 - g. Installation information.
 - h. Other information needed for the preparation of documents supporting the management of operation and maintenance programs.
6. Test Reports and Certifications:
 - a. Copies of tests and certifications performed during manufacture and construction, including but not limited to the following:
 - 1) Certification of installation of vibration isolation.
 - 2) Certification of seismic and wind restraints.
 - 3) Receipt for spare fuses.
 - 4) Receipt for instruction of operating personnel.
 - 5) Certification of installation of HVAC underground preinsulated piping systems.
 - 6) Certification of hydronic system cleaning.
 - 7) Certification of chiller installation and safety and control check-out.
 - 8) Certification of chiller factory performance test.
 - 9) Receipt for extra mechanical seals for pumps.
 - 10) Certification of alignment of pumps.
 - 11) Certification test report for energy recovery units.
 - 12) Certification of operation and accuracy for airflow measurement systems.
 - 13) Certification of BCS calibration and testing.
 - 14) Receipt for BCS training.
 - 15) Receipt acknowledging no BCS failures during test period.
 - 16) Certification of ductwork testing results.
 - 17) Seasonal adjustment reports.
7. Construction Documents:
 - a. Record drawings.
 - b. Approved submittals, including revised shop drawings indicating as-installed conditions.
 - c. Equipment identification charts and schedules.
 - d. Warranty certificates.
 - e. Inspection certificates.
 - f. Test, adjust and balance report.
 - g. Performance verification report.

- E. Submit a receipt signed by the Owner acknowledging receipt of the operation and maintenance documentation package.

3.25 RECORD DRAWINGS

- A. Refer to Section Record Drawings 017839

3.26 DIAGRAMS

- A. Frame and mount the following information:

<u>Information</u>	<u>Location</u>
HVAC diagrams, start-stop procedures, and valve schedules.	Appropriate mechanical rooms.
Automatic temperature control diagrams and sequences.	Adjacent to each control panel.
Appropriate control and interface drawings, including a simplified guide to local programming through the digital display unit, a directory of I/O points connected to that panel, and variables which may be displayed.	Posted on the inside cover of each BCS panel.

- B. Diagrams shall be type written or computer generated.
- C. Diagrams shall be as-built, and shall include interfaces and interlocks with other equipment.
- D. Diagram framing system: 0.125" thick acrylic with satin finish aluminum frames.

3.27 MAINTENANCE

- A. Equipment operated prior to the date of the Architect's final certificate shall be maintained in accordance with manufacturer's recommendations. In addition, provide complete water treatment for hydronic systems operated prior to date of the Architect's final certificate. substantial completion.
- B. Prepare and submit a lubrication chart listing for each piece of equipment:
1. Points requiring lubrication.
 2. Recommendations for a single manufacturer's lubricants with brand name and designation.
 3. Frequency of lubrication required.
- C. Lubricate each item of apparatus requiring lubrication prior to start-up in accordance with the manufacturer's recommendations.

3.28 INSTRUCTION OF OPERATING PERSONNEL

- A. Provide the designated Owner's personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of equipment specified in Division 23. Conduct 2 formal instruction sessions for operating personnel. The first session shall be conducted at the time of start-up and check-out, and the second session shall be approximately 2 months later. Sessions shall be a minimum of 2 days for basic HVAC systems, and as specified herein for specialty systems and equipment. Sessions shall be conducted at the site.
- B. Prepare and submit a syllabus describing an overview of the proposed training program, describing how the training program will be conducted, when and where meetings are to be held, names and company affiliations of lecturers, description of contents and outline for each lecture, and recommended reference material and outside reading. Obtain direction from the Owner on which operating personnel shall be

instructed in each system. Proposed training schedules, materials, and lesson plans shall be submitted to the Owner for review of the content and adequacy of the training of the Owner's personnel.

- C. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor, or manufacturer's representative. More than one party may be required to execute the training. The training program shall include the following, as appropriate for the system or equipment:
1. Training shall normally start with classroom sessions followed by hands-on training for each piece of equipment, which shall illustrate the various modes of operation, including start-up, shutdown, fire/smoke alarm modes, and power failure.
 2. During any demonstration, should the system fail to perform in accordance with the requirements of the operation and maintenance manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
 3. The controls contractor shall attend training sessions for each type of equipment or system controlled by the control system, to discuss the interaction of the control system as it relates to the equipment or system, in addition to the training required for the control system.
 4. Training shall include:
 - a. Use of the printed installation, operation and maintenance instruction material included in the operation and maintenance manuals.
 - b. A review of the written operation and maintenance instructions emphasizing safe and proper operating requirements, preventative and routine maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover, and any emergency procedures.
 - c. Discussion of relevant health and safety issues and concerns.
 - d. Discussion of warranties and guarantees.
 - e. Common troubleshooting problems and solutions.
 - f. Explanatory information included in the operation and maintenance manuals and the location of plans and manuals in the facility.
 - g. Discussion of any peculiarities of equipment installation or operation.
 - h. Classroom sessions shall include the use of overhead projections, slides, video/audio-taped material as appropriate.
 - i. Specific operating and maintenance procedures for:
 - 1) Chillers.
 - j. Factory-trained technicians shall give instruction on the following specialty systems and equipment:

<u>System/Equipment</u>	<u>Minimum Session Duration, hours</u>
Variable frequency drives	4
Chillers	4
 - k. BCS training: as specified in Section 238000, Automatic Temperature Controls.
5. Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment.
 6. Explain and demonstrate the operation, function and overrides of local packaged controls not controlled by the central control system.
 7. Training shall occur after testing is complete, unless approved otherwise by the Owner.
 8. Provide DVD format video recordings of training sessions and a complete record copy of training materials, handouts, and other printed materials used in each training session.
 9. Obtain a receipt acknowledging completion of each item of instruction.

END OF SECTION 230010

COVER SHEET FOR
SUBMITTALS TO NEWCOMB & BOYD

Project: _____ Date: _____

Item: _____ Submittal Number: _____

Manufacturer: _____ Model: _____

Specification Paragraph and/or Drawing Number: _____

Capacity: _____

Electrical Characteristics (including identification of all separate connections or services required): _____

Accessories: _____

Options: _____

Deviations (if any; if none, state so): _____

General Contractor Approval: _____

SECTION 230090 - HVAC PERFORMANCE VERIFICATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other HVAC systems are specified in other Sections of Division 23.
- B. Performance verification is ongoing process and shall be performed throughout construction. Performance verification verifies that systems are operating in a manner consistent with the Construction Documents.
- C. This Section covers HVAC systems performance verification, as required to demonstrate that the equipment and systems of Division 23 are ready for safe and satisfactory operation, as defined by the Construction Documents. Performance verification shall include, but shall not be limited to, identification of piping and equipment, cleaning, lubrication, start-up, check-out, and testing, adjusting, and balancing of systems, preparation of equipment and systems documentation and of maintenance and operation manuals, Owner training, and preparation of record drawings.
- D. The general requirements of the commissioning process and the duties of the Commissioning Authority are detailed in Section 290010, Commissioning. Become familiar with the requirements and coordination obligation of Section 290010, Commissioning and the commissioning schedule issued by the Commissioning Authority as they apply to the work of Division 23, and execute the performance verification responsibilities within the commissioning process as specified therein.
- E. Performance verification shall conclude with the completion of required deferred testing, training, and system documentation as specified herein and required to demonstrate the proper operation of the HVAC equipment and systems provided by this Division.
- F. Verify, at a minimum, the performance of the following systems and equipment and witness the following tests:
 - 1. Section 230010, HVAC General:
 - a. Seismic restraints.
 - b. Variable frequency drives.
 - c. Vibration isolation.
 - 2. Section 231000, Piping, Valves and Accessories:
 - a. Automatic air vents.
 - b. Backflow preventers.
 - c. Expansion tanks.
 - d. Flow meters.
 - e. Temperature maintenance cable.
 - f. Thermostatic air vents.
 - g. Vacuum breakers.
 - h. Water pressure reducing valves.
 - i. Water pressure relief valves.
 - 3. Section 231500, HVAC Underground Preinsulated Piping Systems:
 - a. Chilled water system.
 - b. Underground chilled water system.
 - 4. Section 236000, Equipment:
 - a. Air handling units.
 - b. Air-cooled chillers.

- c. Centrifugal water separators.
 - d. Chiller factory performance test.
 - e. Ductless split systems.
 - f. Electric heating coils.
 - g. Energy recovery wheels.
 - h. Precision air conditioning units.
 - i. Pumps.
 - j. Rooftop air conditioning units.
 - k. Split system air conditioning units.
 - l. Terminal units.
 - m. Water treatment systems.
- 5. Section 236500, Special Equipment:
 - a. Energy recovery units.
- 6. Section 237000, Air Distribution:
 - a. Centrifugal fans.
 - b. Centrifugal power roof ventilators.
 - c. Filter pressure gauges.
- 7. Section 238000, Automatic Temperature Controls:
 - a. BCS.
 - b. BCS acceptance.
 - c. BCS start-up and checkout.
 - d. BCS training.
- 8. Section 230095, Testing, Adjusting, and Balancing:
 - a. Certified test reports.
 - b. Ductwork leakage tests.
 - c. Hydrostatic pressure tests.

1.2 QUALITY ASSURANCE

- A. Provide a HVAC Performance Verification Supervisor with ten years experience in HVAC contracting. The HVAC Performance Verification Supervisor shall become familiar with the Owner's project requirements and the requirements of the performance verification process as defined in this Section. and if applicable, the commissioning process defined in Division 29. The HVAC Performance Verification Supervisor shall coordinate and execute the required performance verification activities.
- B. The HVAC Performance Verification Supervisor shall review submittal data for conformance with the requirements of the Project, shall monitor compliance with the requirements specified herein for storage and protection of equipment during construction, shall authorize the initial starting of equipment and systems in a manner to avoid damage to equipment, shall oversee start-up, testing and balancing, and shall document that the scheduled and specified performance requirements of each system have been accomplished.
- C. Refer to ASHRAE Guideline 0.2-2015, Commissioning Process for Existing Systems and Assemblies, ASHRAE Guideline 1.1-2007, The HVAC+R Technical Requirements for the Commissioning Process, and Guideline 4-2019, Preparation of Operating and Maintenance Documentation for Building Systems.

1.3 PERFORMANCE VERIFICATION RESPONSIBILITIES

- A. The HVAC Performance Verification Supervisor shall be responsible for scheduling, supervising, and coordinating and executing the start-up, testing, and performance verification activities as specified herein.

Include and itemize the cost of performance verification in the contract price, and in each purchase order or subcontract written, include requirements for submittal data, performance verification efforts and documentation, operations and maintenance data, and training as specified herein.

B. HVAC Performance Verification shall take place in three phases. Performance verification requirements for each phase are as follows:

1. Construction Phase:

- a. Attend a performance verification scoping meeting and additional such meetings, initially scheduled monthly until prefunctional testing of equipment and systems begins, and weekly thereafter during the construction phase to facilitate the performance verification process. The HVAC Performance Verification Supervisor shall coordinate meeting attendance. with the Commissioning Authority.
- b. Report in writing to the Commissioning Authority at least as often as performance verification meetings are scheduled, concerning the status of mechanical activities as they affect the performance verification process, the status of each discrepancy identified the prefunctional and functional testing process, explanations of any disagreements with the identified deficiencies, and the proposed resolution and schedule for correction of the deficiency.
- c. Provide documentation of installed systems and equipment, and develop functional testing procedures. This documentation shall include detailed manufacturer installation, start-up, operating, troubleshooting and maintenance procedures; full details of any Owner-contracted tests; fan and pump curves; full factory testing reports, if any; and full warranty information, including responsibilities of the Owner to keep the warranty in force. In addition, the installation, start-up and check-out materials that are actually shipped inside the equipment and the actual field check-out sheet forms to be used by the factory or field technicians shall be submitted to the. Commissioning Authority.
- d. Develop and submit to the Commissioning Authority for review and comment, prior to equipment or system start-up, a complete start-up and initial check-out plan using manufacturer's start-up procedures and prefunctional checklists for the performance of the equipment to be verified.
- e. Assist in clarifying the proposed operation and control of equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
- f. Prepare the specific functional test procedures as specified herein and review the proposed functional test procedures to ensure feasibility, safety, and equipment protection, and provide necessary written alarm limits to be used during the tests. Obtain Commissioning Authority approval for proposed functional test procedures.
- g. Prepare a preliminary schedule for performance verification activities, including pipe and duct system pressure and leakage testing, flushing and cleaning, equipment start-up, and testing, adjusting and balancing start and completion, and update the schedule during the construction period, as appropriate. Notify the Commissioning Authority immediately when the performance verification activities not yet performed or not yet scheduled will delay construction.
- h. HVAC equipment start-up shall not be initiated until completion of pressure and leakage testing and cleaning as specified in other Sections of Division 23.
- i. Provide start-up and prefunctional testing for equipment, including the building control system, and execute the HVAC-related portions of the prefunctional checklists for the verification of the performance of all the equipment during the start-up and initial check-out process.
- j. Perform and document start-up and system operational check-out procedures, providing a copy to the Commissioning Authority.
- k. Correct noncompliance items before beginning functional performance testing. Air and water testing, adjusting and balancing shall be completed with discrepancies and problems remedied before functional testing of the respective air- or water-related systems.

2. Acceptance Phase:
 - a. Place equipment and systems into operation and continue their operation during each working day of the testing, adjusting and balancing, and performance verification activities, as required.
 - b. For each system or area, have required prefunctional checklists, calibrations, start-up and prefunctional tests of the mechanical systems and associated controls completed prior to beginning the testing, adjusting and balancing process.
 - c. Provide sheaves and belts as required to achieve required equipment performance, as measured by the testing, adjusting and balancing work.
 - d. Provide skilled technicians to execute starting and prefunctional testing of equipment and to execute the functional tests for each individual piece of equipment and system. Technicians shall be available and present during the agreed upon scheduled tests and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
 - e. Perform functional testing for specified equipment and interpret the test data, as necessary, under the direction of the Commissioning Authority.
 - f. Correct deficiencies (differences between specified and observed performance) as identified by the HVAC Performance Verification Supervisor, or the Commissioning Authority and interpreted by the Engineer and retest the equipment, as required to demonstrate proper operation and performance.
 - g. Prepare operation and maintenance manuals as specified herein, including clarifying and updating the original sequences of operation to as-built conditions.
 - h. Maintain marked-up record drawings and produce final record drawings of Project drawings and contractor-generated coordination drawings. List and identify on these record drawings the locations of control system components, airflow stations, and sensor installations that are not equipment mounted.
 - i. Provide specified training of the Owner's operating personnel.
 - j. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
3. Warranty Period:
 - a. Execute seasonal or deferred functional testing.
 - b. Correct deficiencies and make necessary adjustments to operations and maintenance manuals and as-built drawings system or equipment modifications made during the warranty period and those identified in any deferred functional performance testing.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Standard testing equipment required to perform start-up, initial check-out, prefunctional, and required functional testing shall be provided for the equipment or system being tested.
- B. Test equipment shall be of the quality and accuracy required to test and/or measure system performance with the tolerances specified and shall have been calibrated within the last 12 months, or as specified herein. Equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates available on request.
 1. Temperature sensors and digital thermometers shall have a certified calibration within the past 12 months and a resolution of $\pm 0.1^{\circ}\text{F}$. Accuracy of temperature test equipment shall be at least twice that of the instrumentation being tested.
 2. Humidity sensors shall have a certified calibration within the past 6 months and a resolution of $\pm 1\%$. Accuracy of humidity test equipment shall be at least twice that of the instrumentation being tested.
 3. Pressure sensors shall have a certified calibration within the 12 months and a resolution of 0.05% of sensor range. Accuracy of pressure test equipment shall be at least twice that of the

- instrumentation being tested.
4. Accuracy of other sensors shall be at least twice that of the instrumentation being tested.

PART 3 - EXECUTION

3.1 SUBMITTALS

- A. Submit additional documentation as required to support the performance verification process. This additional submittal documentation shall include, at a minimum, the proposed start-up and initial check-out procedures, and prefunctional checklists.

3.2 START-UP PLAN AND PREFUNCTIONAL TESTING

- A. Prefunctional testing shall be required for each piece of equipment to ensure that the equipment and systems are properly installed and ready for operation, so that functional testing may proceed without delays. Follow the approved start-up, initial check-out, and prefunctional testing procedures. Sampling strategies shall not be used for prefunctional testing. The prefunctional testing for equipment and subsystems of a given system shall be successfully completed and documented prior to functional testing of the system.
- B. Procedures for performance verification shall include:
 1. Start-up and initial check-out plan: develop the detailed start-up and prefunctional testing plans for equipment and systems that are to be performance verified, as specified herein. Review the proposed procedures and prefunctional testing documentation to ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed.
 2. The start-up and initial check-out plan shall consist, as a minimum, of the following:
 - a. The manufacturer's standard written start-up and check-out procedures copied from the installation manuals and manufacturer's normally used field check-out sheets. The plan shall include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan.
 - b. First-run checklist for equipment, including:
 - 1) Equipment properly set.
 - 2) Alignment of shafts and couplings.
 - 3) Adjustment of vibration isolators.
 - 4) Piping and equipment properly connected.
 - 5) Completion of initial lubrication procedures.
 - 6) Clean filters in place, as appropriate.
 - 7) Wiring properly connected.
 - 8) Electrical overload relays appropriate for load.
 - 9) Electrical accessories properly installed and adjusted.
 - 10) Controls, safeties, and time switches properly set.
 - 11) Verification of direction of motor rotation after final electrical connections by jogging motor.
 - 12) Verification of proper belt tension.
 - 13) Measurement of ampere draw of electric motors and comparison with nameplate rating and with overload heater ratings.
 - 14) Monitoring of temperature build-up in motors and bearings.
 - c. Contractor-developed prefunctional checklists.
 3. Identify which trade is responsible for executing and documenting each of the line item tasks and note that trade on the form. Each form may have more than one trade responsible for its execution.

- C. Four weeks prior to start-up, schedule equipment and systems start-up and check-out and notify the Commissioning Authority in writing. The execution of the prefunctional checklists, start-up and check-out shall be directed and performed by the Contractor, in accordance with manufacturer's published procedures. The Commissioning Authority shall be present for the start-up, check-out, and prefunctional testing of the first unit of each type of equipment, and any other tests he designates.
- D. Sensor calibration: calibration of sensors associated with a given piece of equipment or system shall be included as part of the prefunctional testing and listed on the appropriate test checklists and reports for the system. This requirement may be met during the prefunctional testing of the building control system, but shall also be documented with the functional testing procedures.
- E. Completed start-up, check-out, and prefunctional test forms shall be completed and submitted to the Commissioning Authority for review. List outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies shall be provided to the Commissioning Authority within 2 days of test completion. The Commissioning Authority shall review the Contractor's start-up and prefunctional testing reports and shall submit either a noncompliance report or an approval form to the Contractor. The Contractor shall correct items that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the Commissioning Authority as soon as outstanding items have been corrected and resubmit an updated start-up report and a statement of correction on the original noncompliance report. When requirements are completed, the Commissioning Authority shall recommend approval of the start-up and prefunctional testing of each system and schedule the functional testing of the equipment or system.
- F. Complete start-up and prefunctional testing for a system before functional test of that system may proceed.
- G. Do not operate HVAC systems in a mode that would induce unconditioned, humid outside air into the building.

3.3 RETESTING OF EQUIPMENT AND/OR SYSTEMS

- A. Provide labor and materials required for retesting of any functional test found to be deficient.
- B. Prior to retesting, submit required data indicating that the deficient items have been completed and/or corrected to the Commissioning Authority for approval and rescheduling of the functional test. If during the retesting it becomes apparent that the deficient items have not been completed and/or corrected as indicated in the data provided by the Contractor, the retesting shall be stopped. Costs for the design team to further supervise the retesting of a functional test shall be the responsibility of the Contractor.

3.4 DEFERRED TESTING

- A. Schedule and coordinate, with the approval of the Commissioning Authority, any required seasonal testing, tests delayed until building construction is completed, required building occupancy or loading, weather, or other conditions are suitable for the demonstration of equipment or system's performance, as specified herein. Deferred testing shall be executed, documented, and deficiencies corrected as specified herein for functional testing. Adjustments or corrections to the operations and maintenance manuals and as-built documents required by the results of the testing shall be made before the seasonal testing process is considered complete.

3.5 SEASONAL ADJUSTMENTS

- A. The HVAC Performance Verification Supervisor shall schedule, coordinate and complete the seasonal adjustment process. During this effort the HVAC Performance Verification Supervisor shall:

1. Check and verify the calibration of temperature control devices and thermostats. Test and verify control sequences for proper operation for the season.
2. Check the operation, performance, and balance of air and hydronic systems to provide uniform distribution and comfort conditions.

B. Where deficient operation or defective equipment is discovered, provide corrective measures.

3.6 TESTING DOCUMENTATION, NONCONFORMANCE, AND APPROVALS

- A. List outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the functional test procedure forms or on an attached sheet. The functional test procedure forms and any outstanding deficiencies shall be provided to the Commissioning Authority within 2 days of test completion. The Commissioning Authority shall review the Contractor's start-up and prefunctional testing documentation and shall submit either a noncompliance report or an approval form to the Contractor. Work with the Commissioning Authority to correct and retest deficiencies or uncompleted items. Correct items that are deficient or incomplete in a timely manner, and notify Commissioning Authority as soon as outstanding items have been corrected and resubmit an updated start-up report and a statement of correction on the original noncompliance report. When requirements are completed, schedule the functional testing of the equipment or system.
- B. As functional performance testing progresses and deficiencies are identified, work with the Commissioning Authority to resolve the issues.

3.7 OPERATION AND MAINTENANCE MANUALS

- A. The HVAC Performance Verification Supervisor shall compile and prepare documentation for equipment and systems covered in Division 23 and deliver this documentation for inclusion in the operation and maintenance manuals prior to the training of the Owner's personnel.

3.8 INSTRUCTION OF OPERATING PERSONNEL

- A. The HVAC Performance Verification Supervisor shall schedule, coordinate and assemble, and deliver the documentation of training required by Division 23.

3.9 FUNCTIONAL TESTS

- A. Functional test requirements for the demonstration of proper system and equipment operation shall be defined by the HVAC Performance Verification Supervisor. Execution of these test and demonstration of the required performance shall be the responsibility of the Contractor, under the direction of the Commissioning Authority.
- B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or subsystems at the discretion of the Commissioning Authority. Beginning system testing before full completion of construction shall not relieve the Contractor from fully completing the system, including prefunctional checklists.
- C. Functional testing shall be completed and test documentation approved by the Commissioning Authority before the Project will be considered substantially complete.

END OF SECTION 230090

SECTION 230095 – TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other mechanical systems are specified in other Sections of Division 23.
- B. This Section covers testing, adjusting, and balancing work specified herein, and also indicated on the Drawings, and is defined to include, but is not limited to, air distribution systems, hydronic distribution systems, and associated equipment and apparatus of the new HVAC work. The work consists of setting speed and flow, adjusting facilities provided for systems, recording data, conducting tests, preparing and submitting reports, and recommending modifications to work as indicated on the Drawings or specified herein.
- C. Component types of testing, adjusting, and balancing specified in this Section include the following as applied to HVAC equipment:
 - 1. Air handling units.
 - 2. Chillers.
 - 3. Coils.
 - 4. Ductless split systems.
 - 5. Ductwork systems.
 - 6. Energy recovery units.
 - 7. Fans.
 - 8. Grilles, registers, and diffusers.
 - 9. Piping systems.
 - 10. Pumps.
 - 11. Terminal units.
- D. This Section includes responsibilities and obligations in support of the performance verification specified in Section 230090, HVAC Performance Verification, and commissioning specified in Section_____.

1.2 QUALITY ASSURANCE

- A. Work shall be performed by a firm certified by the National Environmental Balancing Bureau (NEBB), or the Associated Air Balance Council (AABC) in testing and balancing for this type of project.
- B. Conform to:
 - 1. NEBB-2019 Eight Edition Procedural Standards for Testing, Adjusting, and Balancing of Environment Systems, or AABC MN-1-2016, as applicable to mechanical air and hydronic distribution systems and associated equipment and apparatus.
 - 2. ASHRAE recommendations pertaining to measurements, instruments and testing, adjusting and balancing, except as otherwise specified herein.

1.3 SUBMITTALS

- A. Within 30 days after the award of the contract, submit an organizational chart and proof of current certification identifying current certified supervisors in the trade that they are certified.
- B. Immediately upon award of the contract, review the construction documents to determine that:

1. The required testing, adjusting, and balancing devices, e.g., balancing dampers and balancing valves, are included.
 2. The design intent of the systems and their operation to the extent necessary to perform the work is clear.
 3. The systems are capable of being tested, adjusted, and balanced as designed.
 - a. Upon completion of the review, submit a report summarizing the findings, and including any recommendations.
- C. Submit a testing, adjusting and balancing plan that provides a detailed description of the methodology that will be implemented to accomplish the testing, adjusting, and balancing for this Project. Include:
1. Schedule for the Project, with timeline.
 2. Specific testing, adjusting and balancing procedures proposed for each system, tailored to the requirements of the Project. The procedures shall include all "shall" and "should" requirements of the NEBB TAB Procedural Standards.
 3. Instruments that will be used and copy of their latest certification.
 4. Sample testing, adjusting, and balancing report forms proposed for each system.
 5. Single-line schematic flow diagram for each system.
 6. Proposed pitot tube traverse locations.
- D. Submit certified test, adjust and balance reports signed by the supervisor who performed the testing, adjusting, and balancing work, complying with the requirements of this Section and Section 230090, HVAC Performance Verification. Include the following information:
1. Include identification and types of instruments used, their most recent calibration dates, and methods of testing and balancing each system and piece of equipment.
 2. A final test and balance report including all "shall" and "should" requirements of the NEBB TAB Procedural Standards, Chapter 5, Standards for Reports and Forms.
 3. Include AABC or NEBB test forms containing installation data, design data, equipment data, and operating data for systems and equipment, including air handling unit pressure profiles for each unit and duct traverse forms showing all measurements taken at traverse locations.
 4. Include copies of readings with piping layouts and duct layouts showing where readings were taken.
 5. Identification of the index device for each air and hydronic system, and the minimum static or differential pressures required to achieve design flows for those devices.
 6. Include terminal unit correction factors and BCS controller calibration constants for terminal devices and flow measuring installations.

1.4 PROJECT CONDITIONS

- A. Do not proceed with testing, adjusting and balancing work until:
1. Deficiencies in the systems and controls that would prevent complete and accurate testing, adjusting and balancing have been corrected.
 2. Work is complete and systems, including automatic temperature controls, are operable.
 3. Cleaning, flushing, lubrication, and start-up specified in other Sections has been accomplished.

PART 2 - PRODUCTS

2.1 PATCHING MATERIALS

- A. Use the same products and materials for patching holes in insulation, ductwork, and housings which have been cut or drilled for test purposes, including access for test instruments, and attaching jigs, to match existing.

- B. Instrument test ports: as specified in Section 237000, Air Distribution.

PART 3 - EXECUTION

3.1 TESTING, ADJUSTING AND BALANCING

- A. Examine installed work and conditions under which testing is to be done to ensure that work has been completed, cleaned and is operable. Submit a detailed report documenting deficiencies of systems and controls that prevent complete testing, adjusting and balancing. Do not proceed with testing, adjusting and balancing work until unsatisfactory conditions have been corrected.
- B. Provide materials, equipment, labor, and power to test, adjust, and proportionally balance new heating, ventilating, refrigeration, and air conditioning systems and components as indicated on the Drawings and as specified herein. Verify functioning of operating devices and equipment. In addition, the following specific testing, adjusting and balancing shall be performed.

1. Ductwork Leakage Testing:

- a. For ductwork with static pressure classification of 4" wg, 6" wg, or 10" wg, a leakage test shall be made after installation of the first representative sample of ductwork of each classification. The test sample shall incorporate at least: 5 transverse joints, typical seams, one elbow, 2 typical branch connections, and for riser ducts or other systems that include multiple fire dampers, one fire damper and one access door. After satisfactory results for the test sample, additional ductwork shall be tested totaling no less than 25% of the total duct area for each pressure class.
- b. For ductwork with static pressure classification of 1" wg, or 2" wg, a leakage test shall be made after installation of the first representative sample of ductwork of each classification. The test sample shall incorporate at least: 5 transverse joints, typical seams, one elbow, 2 typical branch connections, and for riser ducts or other systems that include multiple fire dampers, one fire damper and one access door. After satisfactory results for the test sample, additional ductwork shall be tested totaling no less than 25% of the total duct area for each pressure class.
- c. Prior to testing, submit drawings indicating sections of ductwork to be tested, including area calculations.
- d. Leakage testing shall be performed in accordance with SMACNA HVAC Air Duct Leakage Test Manual-2012.
- e. Test pressure shall equal the static pressure classification for the duct.
- f. Leakage in each type of ductwork shall not exceed:

1) Rectangular Ductwork:

<u>Static Pressure Classification, wg</u>	<u>Leakage Class</u>
0.5", 1", 2"	16
3"	8
4", 6", 10"	4

2) Round and Flat Oval Ductwork:

<u>Static Pressure Classification, wg</u>	<u>Leakage Class</u>
0.5", 1", 2"	8
3"	4
4", 6", 10"	2

- g. Submit a report certifying ductwork testing and results.

- h. In addition to the tests specified herein, test ductwork located outdoors in accordance with the criteria specified herein for the pressure classification of the ductwork.
 - i. Ductwork failing tests shall be reconstructed and retested until satisfactory, before additional ductwork is installed and before ductwork is concealed.
 - j. Positive pressure testing may be used for negative pressure ductwork.
- 2. Air Systems Balancing, General:
 - a. Test, adjust, and balance systems to achieve operation and design air quantity, temperature differential, and pressure drop through ductwork, equipment, and components.
 - b. Variable frequency drives for fans shall be set up so that a 100% input signal to the variable frequency drive does not overload the fan motor and produces the design fan total static pressure at design airflow. If necessary, fan total static pressure shall be simulated. Adjustment of design airflow shall be accomplished by providing the proper motor sheave.
 - c. Balance air handling units such that duct static pressures are maintained as low as possible while maintaining minimum inlet static pressure and airflow requirements at each terminal unit.
 - d. Total supply, return and outside air airflow for each air handling unit shall be measured using pitot tube duct traverses. Where the outside air inlet configuration is insufficient for a pitot tube duct traverse, the outside air shall be calculated as the difference between the supply and return.
 - e. Determine the minimum and maximum supply duct static pressure setpoints, as described in the air handling unit controls sequences on the Drawings.
 - f. For air handling units with multiple supply duct static pressure sensors, determine unique supply duct static pressure setpoints for each sensor location.
 - g. For systems with diversity, with the fan under control and loads nearest the fan losed off to simulate diversity, verify design flow through each terminal unit. Diversity shall be calculated as the ratio of the total system capacity to the total connected load.
 - h. Adjust pattern adjustment devices in diffusers for horizontal discharge, unless otherwise indicated on the Drawings.
 - i. Calibration of BCS flow elements shall be verified through the use of duct traverses or flow hoods, as appropriate for the device being calibrated. BCS flow elements shall not be used for balance adjustments prior to the verification of their calibration Perform 3-point calibration for airflow measurement systems that will experience variable flow, using the lower and upper airflow limits as two of the calibration points.
 - j. Test, adjust and balance minimum outside air and return dampers to produce the quantity of minimum outside air indicated on the Drawings when each air handling unit is operating at its maximum supply air quantity. Return air dampers shall be adjusted to a less than fully open position only if required to achieve the minimum outside air quantity indicated on the Drawings. Return and minimum outside air damper linkages shall be adjusted to position their respective dampers at full stroke. Permanently mark damper linkage adjustments. Balance and adjust systems to pressurize the entire building, and to minimize stack effect during the winter.
 - k. Balance and adjust individual room air distribution devices to achieve pressure relationships indicated on the Drawings.
- 3. Hydronic Systems Balancing, General:
 - a. Test, adjust, and balance systems to achieve operation and design flow, pressure, temperature differential, and pressure drop through equipment, piping and components.
- 4. Hydronic Systems - Variable Flow, Variable Speed Pumps:
 - a. Operate the system pumps under control and balance terminal devices for design flow with control valves wide open. Record the pump operating data and piping loss data. Do not throttle the pump discharge. Calculate the pump differential pressure setpoint needed to obtain full flow at the worst case load and set the pump controller to that value.

- b. Variable frequency drives for pumps shall be set up so that a 100% input signal to the variable frequency drive does not overload the pump motor and produces the design total head pressure at design flow. If necessary, system total head shall be simulated.
 - c. Balance pumps that are controlled in parallel such that the pump suction and discharge pressures are the same for each pump. The balancing valve associated with each pump shall be adjusted to equalize those pressures.
 - d. Balance hydronic systems such that distribution system differential pressures are maintained as low as possible while maintaining the minimum differential pressure and volume requirements at connected loads.
 - e. For systems with diversity, with the pump under control and loads nearest to the pump closed off to simulate diversity, verify design flow through each terminal device. Diversity shall be calculated as the ratio of the total system capacity to the total connected load.
 - 5. Hydrostatic Pressure Testing:
 - a. Test piping systems in accordance with the ASME standards specified in Section 231000, Piping, Valves and Accessories, and Section 231500, HVAC Underground Preinsulated Piping Systems.
 - b. Test shall be held for 4 hours, minimum, with compensation made for temperature change.
 - c. No pressure change allowed.
 - 6. Seasonal adjustments: as specified in Section 230090, HVAC Performance Verification.
 - C. Submit report of system deficiencies, leaks, or defects that must be corrected to successfully pass tests.
 - D. Patch holes in insulation, vapor barriers, ductwork, and housings, which have been cut or drilled for test purposes.
 - E. Position and secure memory stops on valves used for balancing.
 - F. Mark equipment settings, including damper control positions, valve indicators, memory stop positions, and controls and devices, to show final settings at completion of testing, adjusting, and balancing work. Provide markings with paint or permanent identification materials.
 - G. Prior to the date of the Architect's final certificate after balancing is complete, furnish labor, equipment and materials to verify a random 20% selection of all conditions.
 - H. Pressure and leakage tests of the piping and ductwork systems shall be made in the presence of the Owner.
- 3.2 SEASONAL ADJUSTMENTS
- A. Assist the HVAC Performance Verification Supervisor with the seasonal adjustment process. During this effort the HVAC Performance Verification Supervisor will:
 - 1. Check the operation, performance, and balance of air and hydronic systems to provide uniform distribution and comfort conditions.
 - 2. Where deficient operation or defective equipment is discovered, Contractor shall provide corrective measures as required by the warranty provisions of these specifications and shall assist the Performance Verification Supervisor in the correction of these deficiencies.

END OF SECTION 230095

SECTION 231000 – PIPING, VALVES AND ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other mechanical systems are specified in other Sections of Division 23.
- B. This Section covers piping, fittings, valves and accessories for heating, ventilating, and air conditioning systems, and, except as otherwise specified herein, does not cover fuel, plumbing, or fire protection systems.
- C. Testing, adjusting, and balancing is specified in Section 230095, Testing, Adjusting and Balancing.
- D. This Section includes responsibilities and obligations in support of the performance verification specified in Section 230090, HVAC Performance Verification, and commissioning specified in Section_____.

1.2 QUALITY ASSURANCE

- A. Piping systems shall meet ASME B31.9-2017, Building Services Piping.
- B. Components of the same type shall be products of the same manufacturer.
- C. Welder certification: welders shall be certified under the rules of the National Certified Pipe Welding Bureau and qualified by either the National Certified Pipe Welding Bureau or an independent testing laboratory for the procedures used on this Project.
- D. Welding procedures: in accordance with ASME B31.9-2017, for the service involved. Welds shall be full penetration type, accomplished by proper beveling and spacing of pipe ends. Where backing rings are specified herein, root pass shall penetrate into the backing ring.
- E. Pressure/temperature ratings of components and accessories shall meet or exceed design conditions for the system in which they are installed. Components and accessory items shall be designed for operating conditions of not less than:

<u>System</u>	<u>Rating</u>
Chilled	200 psig and 250°F

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

- A. Pipe:

<u>Service</u>	<u>Joints</u>	<u>Material</u>
Chilled, water, 2.5" through 10"	Welded	Black steel, schedule 40, ASTM A53/A53M-2018

<u>Service</u>	<u>Joints</u>	<u>Material</u>
Chilled, 2" and smaller	Soldered or Threaded	Copper tubing, type L, hard drawn ASTM B88-2016 or Black steel, schedule 40, Grade B, ASTM A53/A53M-2018
Refrigerant	Brazed	Copper tubing, type ACR, hard drawn, ASTM B280-2019
Chilled water chemical treatment systems	Threaded	Black steel, schedule 40, ASTM A53/A53M-2018
Coil condensate drain	Soldered	Copper tubing, type L, hard drawn, ASTM B88-2016
B. Fittings for type L copper 2" and smaller shall be wrought copper, solder joint fittings, 1. Solder joint fitting manufacturer: Elkhart, Mueller, or NIBCO. 2. Press joint fitting manufacturer: NIBCO Press, Victaulic Vic Press, or Viega Pro Press.		
C. Fittings for black steel schedule 40 pipe, 2" and smaller, shall be standard weight black malleable iron. Fittings for black steel pipe 2.5" and larger shall be black steel ASTM A234/A234M-2019 Grade WPB of a service class to match the adjacent pipe, except that connections to valves and equipment shall be made with ASTM A105/A105M-2018 flat face welding neck flanges. or grooved ends.		
D. Branch connections: forged steel, welding nipple type. 1. Manufacturer: Bonney Forge, Capital, or WFI.		
E. Fittings for steel tubing shall be slip fit or slip coupling type, same material and gauge as tubing. Provide threaded adaptors for installation of ball valves. 1. Manufacturer: Spencer Turbine Company.		
F. Elbows: long radius type, except where space conditions do not permit.		
G. Solder: 95/5 tin/silver or tin/antimony alloy type.		
H. Flux: ASTM B813-2016.		
I. Refrigerant Pipe and Accessories: 1. Fittings: sweat type, wrought copper. 2. Stop valves: up to 3.125" od, ball type, designed for refrigerant service, with seal caps; above 3.125" od, globe type, back-seating, with seal caps. a. Manufacturer: Alco, Henry, Kerotest, or Watsco. 3. Test valves: 0.25" male flare globe type, back-seating with seal caps. 4. Expansion valves: thermostatic, pressure balanced type with external equalizer connections. a. Manufacturer: Alco, Parker, or Sporlan.		

5. Filter-dryers: molded porous core type, serviceable for systems 10 tons and larger and nonserviceable for systems smaller than 10 tons.
 - a. Manufacturer: Alco, Parker, or Sporlan.
6. Moisture and liquid indicators: Alco, Henry, Parker, or Sporlan.

J. Brazing Alloys:

1. For copper-to-copper joints: AWS A5.8/A5.8M-2011, Classification BCuP-5, 15% silver brazing alloy with a melting point range of 1300°F to 1500°F.
2. For dissimilar metal joints: AWS A5.8/A5.8M-2011, Classification BAG-1, 45% silver brazing alloy with a melting point of 1145°F to 1400°F.
3. Flux: approved by brazing alloy manufacturer.
4. Manufacturer: Airco, Handy & Harman, or Harris.

2.2 VALVES AND STRAINERS

A. Body construction, unless specified otherwise herein:

1. 250 psig service and lower: cast iron.
2. 300 psig service and higher: forged steel.

B. Butterfly valves: lug type with cast or ductile iron body, EPT (EPDM) seat designed for service at 200°F, type 304, 316, or 416 stainless steel stem, and conforming to MSS SP-67-2017. Shaft bushings shall be permanently lubricated bronze, TFE-coated stainless steel, nylon, or acetal. Operators shall be the lever and quadrant type with memory stops for valves 6" and smaller. and valves used for balancing. Operators shall be the manual handwheel gear type for valves 8" and above. Butterfly valves shall be factory hydrostatically tested at 150% of the pressure rating specified herein and shall be factory-tested bubbletight at 150 psi disc differential. and shall be designed for dead-end service without a back-up flange. Butterfly valves shall be 2.5" size and larger.

1. Manufacturer: Apollo, Bray, Crane, Keystone, Kitz, Milwaukee, NIBCO, or Stockham.

C. Ball valves: bronze body, full port, chromium-plated brass ball, TFE seals and seats, blowout-proof stem, and soldered or threaded ends conforming to MSS SP-110-2010. Ball valves shall be 2" size and smaller. Ball valves in insulated piping shall be provided with extended lever or stem. Ball valves used for balancing shall have memory stops.

1. Manufacturer: Apollo, Crane, Kitz, Milwaukee, NIBCO, or Stockham.

D. Check valves installed in horizontal pipe: swing-type with full flow area. Valves 2" and smaller shall be threaded bronze body with Teflon or composition discs conforming to MSS SP-80-2019. Valves 2.5" and larger shall be flanged body with Teflon, cast iron, or composition discs conforming to MSS SP-70-2011. Check valve hanger pins shall be supported at both ends by removable side plugs.

1. Manufacturer: APCO, Hammond, Kitz, Milwaukee, NIBCO, or Wheatley.

E. Check valves installed in vertical pipe and at pump discharges: spring-loaded silent-type. Seats, discs, and guides shall be bronze or stainless steel with stainless steel or bronze return spring. Disc shall be fully guided top and bottom. Valves shall have an open area equal to 10% more than the related pipe size area. Valves 2" and smaller shall be threaded bronze body. Valves 2.5" and larger shall be flanged conforming to MSS SP-125-2018.

1. Manufacturer: APCO, Hammond, Kitz, Milwaukee, NIBCO, or Wheatley.

F. Control valves: as specified in Section 238000, Automatic Temperature Controls.

- G. Strainers: Y-type, flanged body with removable type 316 stainless steel or monel screens. Strainers 2.5" and larger shall be provided with a plugged gate valve and nipple the full size of the strainer blowdown outlet. Strainers 2" and smaller shall be threaded, bronze body type. Strainers 2.5" and larger shall be flanged.

1. Water Service:

<u>Pipe Size</u>	<u>Strainer Perforation Size</u>
0.75" to 1.5"	20 mesh
2" to 3"	0.062"
4" and above	0.125"
Chiller inlet (all sizes)	20 mesh

- H. Suction diffusers: angle type body with inlet vanes and combination diffuser strainer-orifice cylinder with 0.188" diameter openings. Unit shall be equipped with disposable fine mesh start-up strainer. Strainer free area shall be no less than 5 times the section area of the pump connection. Unit shall be provided with adjustable support foot.

- I. Water pressure relief valves: bronze body construction with a steel spring. Valves for hot water applications shall be ASME rated.

1. Manufacturer: Aquatrol, Kunkle, Watts, or Wilkins.

- J. Water pressure reducing valves: bronze body construction with a stainless steel spring, and renewable seat.

2.3 ACCESSORIES

- A. Unions:

- Unions in black steel piping 2" and smaller, except as specified herein, shall be black malleable iron, ground joints, bronze seated of the service class to match the adjacent piping, with screwed end connections.
- Unions in copper piping shall be cast brass or bronze with copper soldered connections.

- B. Dielectric fittings: threaded, flanged, brazed, or soldered to match adjacent piping. Metal parts of the union shall be separated so that the electrical current is below 1% of the galvanic current which would exist with metal-to-metal contact.

1. Manufacturer: Bolt-Pak, Epco (with high temperature gasket), Perfection Clearflow, or Watts.

- C. Automatic air vents: float-operated automatic type with cast iron body, stainless steel trim, 0.75" piping connections, and minimum 175 psig water working pressure.

1. Manufacturer: Anderson, Armstrong, or Hoffman.

- D. Thermostatic air vents: self-adjusting, balanced thermostatic type with welded multiple plate stainless steel bellows. Body shall be brass with 0.5" piping connections and stainless steel internal components. Thermostatic air vents shall be rated for 125 psig.

1. Manufacturer: Armstrong TV-2, Hoffman 8C, or Spirax Sarco T202.

- E. Vacuum breakers: brass or stainless steel body, stainless steel retainer tube, ball or spring, and resilient seat.

1. Manufacturer: Armstrong, Colton, Hoffman, Johnson, or Spirax Sarco.

- F. Pressure gauges: bourdon tube type with metal case, 4.5" dials, accuracy within 1% of full scale range, equipped with snubbers and needle valves. Gauges at pumps and chillers shall be liquid-filled

<u>Service</u>	<u>Range</u>
Chilled water pumps	0/100 psig

1. Manufacturer: Ashcroft, Marsh, Trerice, Weiss, or Weksler.

- G. Dial thermometers: bimetallic element, dial type with minimum 3" dials, stainless steel case, angle or straight as required. Thermometers installed in uninsulated piping shall have 4" stems with brass separable sockets. Thermometers installed in insulated piping shall have 6" stem with brass separable socket with extension neck equal to thickness of insulation. Thermometers installed in ducts shall have 6" stems with duct mounting flanges.

<u>Service</u>	<u>Range</u>
Chilled water	0°/150°F

1. Manufacturer: Ashcroft, Marsh, Palmer, Taylor, Trerice, Weiss, or Weksler.

- H. Thermometer test wells: brass construction with brass plug and chain, designed for use with partial immersion laboratory type test thermometers. Test wells in insulated piping shall have an extension neck equal to thickness of insulation.

1. Manufacturer: Ashcroft, Moeller, Taylor, Trerice, Weiss, or Weksler.

- I. Flow Meters:

1. Venturi Type:
 - a. Venturi type, complete with venturi, pressure taps, quick connect couplings, and bar stock needle valves. Venturies 4" through 8" shall be zinc-plated cast or fabricated steel, and 10" and larger shall be fabricated steel. Venturies shall have weld ends.
 - b. Provide vinyl laminated tag attached to venturi with chain indicating size, location, flow rate and differential pressure reading. Venturi shall be selected for the required minimum and maximum flow rates to read within the appropriate range on a 0" wg to 300" wg master meter.
 - c. Venturi accuracy over flow range shall be $\pm 1\%$.
 - d. Venturi shall have a minimum working pressure rating of 300 psig at 150°F.
 - e. Provide one portable meter set, including checking hoses, check seal and carrying case. Wetted parts of the meter shall be stainless steel. Meter shall be diaphragm type with variable pulsation damping control, zero adjustment control, and bleed valves. Meter shall be designed for system velocities and temperatures. Accuracy of complete system shall be $\pm 3\%$.
 - f. Venturi shall be provided with wall-mounted meter reading gpm with $\pm 5\%$ accuracy, in addition to master meter taps.
 - g. Manufacturer: Bailey, Barco, or BIF, or.

- J. Automatic Flow Control Valves:

1. Valves 2" and smaller shall have soldered or threaded ends with brass or bronze body; and 2.5" and larger shall have flanged ends with iron body. Valves shall have pressure/temperature test plugs for verifying the pressure differential across the assembly and system temperature.
2. Valves shall automatically control flow rates within $\pm 5\%$ accuracy over an operating pressure differential range of at least 14 times the minimum required for control. At least 2 operating pressure ranges shall be available with the minimum range requiring less than 3 psig to activate the mechanism. Provide flow capacity characteristic curves or tables for each valve size.

3. Valve internal control mechanisms shall consist of a corrosion resistant cartridge with segmented port design and full travel linear coil spring. Valves shall have Y-body housing or other means to provide access to internal control mechanism without removing the valve.
 4. Manufacturer shall provide certified independent laboratory test verifying accuracy of performance.
 5. Provide one portable meter set, including checking hoses, check seal and carrying case. Wetted parts of the meter shall be corrosion resistant. Meter shall be diaphragm type with variable pulsation damping control, zero adjustment control, and bleed valves. Meter shall be designed for system velocities and temperatures.
 6. Manufacturer: Flow Design, Griswold, IMI, or Kates.
- K. Expansion Tanks:
1. Expansion tanks shall be bladder type, welded steel, designed, constructed, certified, and stamped in accordance with ASME BPVC-VIII-1-2019 for a working pressure of 125 psig. Bladders shall be replaceable elastomeric butyl rubber type, designed for a maximum operating temperature of 240°F.
 2. Manufacturer: Bell & Gossett, MEPCO, Taco, Wessels, or Wheatley.
- L. Combination Pressure and Temperature Test Plugs:
1. Combination pressure and temperature test plugs may, at the Contractor's option, be used on pipe sizes 2" and smaller, for maximum 150 psig service, in lieu of the needle valves and thermometer test wells specified herein or indicated on the Drawings. Plugs shall not be used at locations specified herein or indicated on the Drawings to have a pressure gauge or thermometer permanently installed. Plugs shall have brass bodies, and internal valve seat material designed for specific system operating temperature and pressure. Plugs shall be provided with adaptors to connect pressure gauges or thermometers identical to those used elsewhere on the Project.
 2. Manufacturer: Fairfax, Flow Design, Peterson, or SISCO.
- M. Temperature Maintenance Cable:
1. Self-Regulating Heating Cable:
 - a. Cable shall consist of 2 #16 AWG nickel-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature along its length. Cable shall be covered by a crosslinked, modified polyolefin dielectric jacket. Cable shall have a braid of tinned-copper and an outer jacket.
 - b. Cable components shall be UL listed to provide freeze protection flow maintenance as required.
 - c. System shall be controlled manually, either directly or through a contactor.
 - d. System shall be controlled by an ambient a line sensing thermostat set at 40°F, either directly or through a contactor.
 - e. Manufacturer: Brisk-Heat SL series, Chromalox, Easy Heat, Nelson Electric, Raychem XL-Trace, or Thermon.
 2. Constant Wattage Cable:
 - a. For maximum surface temperature of 150°F: UL listed, self-regulating type with TPE sheath, tinned-copper braid, and thermoplastic rubber outer jacket, complete with power connection kits. Surface temperature of plastic pipe shall not exceed manufacturer's recommendation for service and type of pipe.
 - b. For surface temperatures between 150°F and 250°F: UL listed, constant-watt zone type cable with TPE sheath, tinned-copper braid and thermoplastic outer jacket, complete with power connection kits.
 - c. For surface temperature of 250°F or higher: UL listed, mineral insulated type with fire resistant sheath, complete with power connection kits.
 - d. Provide 2 thermostats in series. The first thermostat shall remain open until the ambient temperature drops below 45°F and the second thermostat shall be the line sensing type to

- maintain pipe temperature at 35°F with an ambient temperature of -20°F. Each set of thermostats shall control all temperature maintenance cable in a common location, up to maximum 30 A.
- e. Manufacturer: Brisk-Heat FE series, Chromalox, Easy Heat, Nelson Electric, Raychem, or Thermon.
- N. Inline air separators: centrifugal inline tank type, capable of handling the water flow indicated on the Drawings, and constructed for 125 psig working pressure.
- 1. Manufacturer: Armstrong, Bell & Gossett, Taco, Thrush, or Wheatley.
- O. Gaskets: 0.063" thick, conforming to ASME B16.5-2017, asbestos-free, selected for the pressure, temperature and service of the specific joint.
- 1. For other services: composition sheet type.
- P. Bolting Materials:
- 1. For maximum system ratings of 250°F and 160 psig:
 - a. Bolts and studs: ASTM A307-2014e1, Grade B, zinc-plated.
 - b. Nuts: ASTM A563-2015, Grade A, heavy hex, zinc-plated.
- Q. Pipe Alignment Guides:
- 1. For steel piping: bolted 2-section outer cylinder type, with a 2-section guiding spider.
 - a. Manufacturer: Anvil 255, Elcen 411A, or ERICO 650.
 - 2. For copper tubing: same as for steel piping but with a copper spider.
 - 3. Guides and spiders shall be designed to clear pipe insulation and to prevent overtravel.

PART 3 - EXECUTION

3.1 GENERAL

- A. Before erection, clean interior and exterior of pipe and fittings of slag, spatter, rust, dirt and debris by wire brushing and swabbing.
- B. Workmanship: pipe shall be cut to measurements established at the Project site and worked into place without springing or forcing. Pipes shall be installed to permit free expansion and contraction without damage to joints, hangers, or the building.
- C. Changes in direction shall be made with fittings, except where branches are two or more sizes less than the size of the main, the branch may be made using branch connections, weldolets, threadolets, latrolets, sweepolets, and elbolets.
- D. Pitch/grade: piping shall be installed with sufficient pitch to ensure drainage and venting.
- E. Solder joint connections shall be cut, deburred, cleaned and assembled in accordance with ASTM B828-2016.
- F. Threaded connections: screw-thread joints shall be made with cut tapered threads. Joints shall be made tight with Teflon tape unless otherwise specified herein. Not more than 2 threads shall show after the joint is made tight. Pipes shall have burrs removed by reaming cut end.

G. Welding:

1. Mitering or notching pipe to form elbows and tees will not be permitted. Field and shop bevels shall be in accordance with the standards specified herein and shall be done by mechanical means or flame cutting. Where beveling is done by flame cutting, surfaces shall be cleaned of slag, scale and oxidation prior to welding. Before welding, the component parts to be welded shall be aligned so no strain is placed on the weld when finally positioned. Height shall be aligned so that no part of the pipe wall is offset by more than 20% of the wall thickness. Flanges and branches shall be set true. This alignment shall be preserved during the welding operations. Connections larger than 6" shall be made with backing rings at welds.
2. Where the temperature of the component parts being welded reaches 32°F or lower, the material shall be heated to approximately 100°F for a distance of 3' on each side of the weld before welding, and the weld shall be finished before the material cools to 32°F.
3. Welders shall stamp each weld with their personal symbol or code number.
4. Current welder certifications for welders performing welding on this Project (on or off-site) shall be maintained at the Contractor's site office and shall be readily available for review.
5. A random sample of completed pipe welds may be chosen by the Engineer for visual testing by an independent testing agency, not to exceed 5% of the total welds on the Project. Costs for testing shall be borne by the Contractor. Acceptance criteria shall be as specified by ASME B31.9-2017. If any of the tested welds are unsatisfactory, additional welds may be chosen for testing at the Contractor's expense.
6. Defective welds shall either be cut out and rewelded or ground down to base metal and rewelded. Reworked welds shall be tested as specified herein.

H. Flanged joints in water piping shall be made with ring type gaskets, extending to inside of bolt holes. Flanged connections to equipment shall be made with full face gaskets to match flanges on equipment.

I. Install piping so as to preserve access to valves, air vents, and equipment requiring access, and to provide the maximum headroom.

J. Provide offsets to maintain ceiling height and to coordinate with other trades.

K. Install piping such that when insulation is applied it will not come in contact with adjacent surfaces.

L. Provide reducing fittings for changes in pipe sizes.

M. Perform pressure tests required by Section 230095, Testing, Adjusting and Balancing before work is concealed or buried.

N. Piping failing the tests specified in Section 230095, Testing, Adjusting and Balancing shall be repaired until satisfactory.

3.2 VALVES AND STRAINERS

A. Valves in horizontal piping shall be installed with stems at or above the pipe centerline.

B. Butterfly valves may be used in lieu of the gate and balancing valves indicated on the Drawings for 125 psig and 200°F chilled, and condenser water service.

C. Ball valves may be used in lieu of the gate and balancing valves indicated on the Drawings for chilled, hot, and condenser water service.

D. Butterfly valves adjacent to equipment shall be functional when equipment is removed.

- E. Control valves: install in accessible locations, with room for actuator removal and service. Adjust the actuators to provide tight closure. Provide valve stem travel indicators and adjust to indicate proper travel. Where butterfly valves are used, permanently mark the end of the valve shafts to indicate valve position.
- F. Strainers in water piping shall be installed with blowdown outlets at the low point.
- G. Suction diffusers: install at the inlet of end suction pumps, in lieu of the strainer indicated on the Drawings.

3.3 ACCESSORIES

- A. Pressure Gauges:
 - 1. Install a gauge at the highest point of each closed hydronic system.
 - 2. Install as indicated on the Drawings, unless otherwise specified herein.
- B. Dial thermometers: install as indicated on the Drawings, unless otherwise specified herein.
- C. Thermometer test wells: install as indicated on the Drawings, unless otherwise specified herein. Fill with a thermally conductive material.
- D. Thermometers and thermometer test wells shall be installed on a 45° angle in vertical piping and vertically in horizontal piping.
- E. Thermometers, needle valves, pressure gauges, and thermometer test wells shall be installed so as to not be obscured by piping, building structure, or equipment.
- F. Flow meter connections with isolation valves shall be extended and attached to the wall 5' above the floor with channel struts. Wall-mounted meters shall be mounted 5' above the floor.
- G. Install control valves, thermometers, and valved pressure taps provided under Section 238000, Automatic Temperature Controls.
- H. Temperature Maintenance Cable:
 - 1. Install and test before insulation is applied, in accordance with manufacturer's recommendations.
 - 2. Install on exterior water supply and return piping,
 - 3. Secure cable to the piping with cable ties or fiberglass tape.
 - 4. Do not cross cable with itself.
 - 5. Hard wire power connections to junction box.
- I. Inline Air Separators:
 - 1. Provide a 0.75" drain with valve on the separator tank.
 - 2. Support with hangers independently from the adjacent piping.
- J. Bolting Materials:
 - 1. Lubricate bolt and stud threads with molybdenum disulfide anti-seize compound.
 - 2. Bolts and studs, when installed, shall extend not less than 2 full threads through nuts when tightened to the required torque.
 - 3. Install washers under bolt heads and nuts.
- K. Pipe Alignment Guides:
 - 1. Pipe alignment guides shall be bolted to piping and the spiders shall be fully insulated.
 - 2. Bolt outer housings of guides to the structure.

3.4 UNIONS AND FLANGES

- A. Provide unions or flanges for disconnecting pipe from valves and equipment, and as indicated on the Drawings.
- B. Dielectric fittings shall be used for connections between ferrous piping or equipment and nonferrous piping or equipment, except that brass and bronze valves shall not be isolated in predominantly steel piping systems.

3.5 WATER SUPPLY AND RETURN PIPING

- A. Arrange piping for the venting of air and for drainage of the entire system.
- B. Changes in size of vertical piping shall be made with concentric reducers, and in horizontal piping shall be made with eccentric reducers to maintain uniform top elevation of pipe.
- C. Extend drain piping from chilled water pump drain pans to floor drain. Route pipe tight to equipment foundations and avoid obstructing access paths and maintenance areas.
- D. At each low point of the system, provide a 0.75" drain valve with hose thread, and at each high point and in every drop in the direction of flow of supply and return mains provide a manual air vent valve, unless otherwise indicated on the Drawings or specified herein.
- E. Provide 1.5" fill and drain valves at each connection of new water piping to existing water piping. Locate fill valves on top of new supply pipe and drain valves at bottom of new return pipe.
- F. Provide crossover connections and valves as required in order to perform cleaning as specified in Paragraph 3.6, Cleaning.

3.6 CLEANING

- A. Chilled, Piping:
 - 1. Fill and flush with clean water.
 - 2. Refill with clean water, then add cleaning/degreasing detergent.
 - a. Approved by local, state and federal authorities for the intended use.
 - b. With nonfoaming wetting agent.
 - c. Concentration of the detergent shall be 2% of the active ingredients of the chemicals used for cleaning.
 - d. Supplied and supervised by water treatment company.
 - 3. Circulate water, using temporary pumps as required, in each system at respective design flow rates, minimum, for three 8 hour periods.
 - a. At the end of each 8 hour period: remove and clean strainers. Blow-off low points.
 - 4. After third period of pumping, drain entire system of cleaning solution.
 - a. Clean out cooling tower basins and hose down.
 - 5. Refill systems with clean water and circulate for an additional 8 hour period. Remove and clean strainers. Drain and refill with clear water. Continue to circulate water.
 - 6. Test for alkalinity, not more than 200 ppm in excess of alkalinity of rinsing water.
 - 7. Repeat process described above until 200 ppm in excess of alkalinity of rinsing water, or less is maintained for 10 days.
 - 8. Protect against damage from freeze-up or discharge of water.

9. When cleaning is completed, fill systems with clear water, and circulate with appropriate water treatment chemicals to protect pipe and equipment until the date of the Architect's final certificate.
10. Immediately prior to the date of the Architect's final certificate, remove and clean strainers.
11. Use and disposal of chemicals shall comply with local, state, and federal regulations.

3.7 PIPING SYSTEMS

- A. Manually operate relief valves and verify that discharge openings and piping are clear and free flowing.
- B. Open air vents until air is removed from the systems.

END OF SECTION 231000

SECTION 231500 – HVAC UNDERGROUND PREINSULATED PIPING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other mechanical systems are specified in other Sections of Division 23.
- B. This Section covers HVAC underground preinsulated piping systems, including chilled water.
- C. Testing, adjusting and balancing is specified in Section 230095, Testing, Adjusting and Balancing.
- D. This Section includes responsibilities and obligations in support of the performance verification specified in Section 230090, HVAC Performance Verification, and commissioning specified in Section _____.

1.2 QUALITY ASSURANCE

- A. Piping systems shall meet ASME B31.9-2017, Building Services Piping.
- B. Pressure/temperature ratings of components and accessories shall meet or exceed design conditions for the system in which they are installed. Components of the same type shall be products of the same manufacturer. Components and accessory items shall be designed for operating conditions of not less than:

<u>System</u>	<u>Rating</u>
Chilled	200 psig and 250°F

- C. Welder certification: welders shall be certified under the rules of the National Certified Pipe Welding Bureau and qualified by either the National Certified Pipe Welding Bureau or an independent testing laboratory for the procedures used on this Project.
- D. Welding procedures: in accordance with ASME B31.9-2017, for the service involved. Welds shall be full penetration type, accomplished by proper beveling and spacing of pipe ends. Where backing rings are specified herein, root pass shall penetrate into the backing ring.

PART 2 - PRODUCTS

2.1 UNDERGROUND CHILLED WATER SYSTEMS

- A. General:
 - 1. Underground chilled water, piping shall be the preinsulated type consisting of a carrier pipe, insulation, and protective jacket. The carrier pipe shall be insulated with polyurethane foam and enclosed with a protective jacket of FRP, PVC, or HDPE. Straight sections, fittings, anchors and accessories shall be factory prefabricated to site dimensions and designed to minimize the number of field welds.
 - 2. Straight sections and fittings shall be supplied with 6" to 8" of piping exposed at each end for field-insulating the joints. Ends of straight sections and fittings shall be fitted with end seals for moisture protection. Additionally, end seals shall be provided for ends terminating at wall and slab penetrations in manholes, tunnels, concrete trenches, and the floor slab of the finished building.

B. Insulation:

1. Straight sections and fittings shall be prefabricated and pre-insulated at the factory with polyurethane foam. The foam shall completely fill the annular space between carrier pipe and protective jacket, and shall have the following properties: minimum 2 pcf density, 90%-95% closed-cell content, and maximum K-value of 0.16 Btu·in/(h·ft²·°F) at 75°F.
2. The minimum insulation thickness shall be as follows:

<u>Piping</u>	<u>Insulation Thickness</u>
Chilled water	1"

3. Joints shall be field-insulated by pouring polyurethane foam into the field joint area and sealing with heat shrink wrap, or by securing preformed polyurethane sections to the field joint area and sealing with a sleeve and heat shrink tape. Field-insulated areas shall be watertight and have a continuous seal with the prefabricated sections.
4. The insulation and jacket at fittings shall be the same thickness and quality as for the straight sections.

C. Protective Jackets:

1. Protective jackets shall be filament wound, polyester resin/fiberglass reinforcement composite (FRP); seamless polyvinyl chloride (PVC), Type 1, Grade 1, conforming to ASTM D1784-2011; or high-density polyethylene (HDPE), Type III, Class C conforming to ASTM D1248-2016.
2. The minimum wall thickness for FRP jackets shall be as follows: for jacket diameter up to 15.5", 0.055"; jacket diameter between 15.6" and 24.5", 0.085"; jacket diameter between 24.6" and 31.0", 0.110"; and jacket diameter between 31.1" and 40.0", 0.140".
3. The minimum wall thickness for PVC jackets shall be as follows: for jacket diameter up to 5", 0.060"; 6" jacket diameter, 0.070"; jacket diameter greater than 6", 1% of diameter.
4. The minimum wall thickness for HDPE jackets shall be as follows: for jacket diameter up to 12", 0.125"; jacket diameter between 12.1" and 24", 0.15"; jacket diameter greater than 24", 0.175".

D. Prefabricated plate anchors: 0.5" thick steel plates welded to the carrier pipe.

E. Underground chilled water, and hot water systems shall be shipped from the factory with plastic pipe end covers installed with tape on the piping.

F. Manufacturer: Perma-Pipe/Ricwil, Rovanco, Thermacor, or Thermal Pipe Systems.

2.2 MATERIALS

A. Chilled Water:

1. Pipe, fittings, and accessories: as specified in Section 231000, Piping, Valves and Accessories.
2. Valves, and strainers: as specified in Section 231000, Piping, Valves and Accessories, except where specified herein.

PART 3 - EXECUTION

3.1 GENERAL

- A. HVAC underground preinsulated piping systems shall be installed in a coordinated manner, at the same time, and in the same proximity as other site utilities defined in other Divisions.
- B. Piping, insulation, protective jackets, and other materials required for a complete HVAC underground preinsulated piping system shall be furnished by the manufacturer and installed in accordance with manufacturer's installation instructions.
- C. Excavation and backfill: as specified in Section 230010, HVAC General.
- D. Changes in direction shall be made with fittings, except where branches are two or more sizes less than the size of the main, the branch may be made using branch connections, weldolets, latrolets, sweepolets, and elbolets.
- E. Pitch/grade: piping shall be installed with sufficient pitch to ensure drainage and venting.
- F. Welding:
 - 1. Mitering or notching pipe to form elbows and tees will not be permitted. Field and shop bevels shall be in accordance with the standards specified herein and shall be done by mechanical means or flame cutting. Where beveling is done by flame cutting, surfaces shall be cleaned of slag, scale and oxidation prior to welding. Before welding, the component parts to be welded shall be aligned so no strain is placed on the weld when finally positioned. Height shall be aligned so that no part of the pipe wall is offset by more than 20% of the wall thickness. Flanges and branches shall be set true. This alignment shall be preserved during the welding operations. Connections larger than 6" shall be made with backing rings at welds.
 - 2. Where the temperature of the component parts being welded reaches 32°F or lower, the material shall be heated to approximately 100°F for a distance of 3' on each side of the weld before welding, and the weld shall be finished before the material cools to 32°F.
 - 3. Welders shall stamp each weld with their personal symbol or code number.
 - 4. A random sample of completed pipe welds may be chosen by the Engineer for visual and radiographic testing by an independent testing agency, not to exceed 5% of the total welds on the Project. Costs for testing shall be borne by the Contractor. Test criteria shall be as specified by ASME B31.1-2018. If any of the tested welds are unsatisfactory, additional welds may be chosen for testing at the Contractor's expense.
 - 5. Defective welds shall either be cut out and rewelded or ground down to base metal and rewelded. Reworked welds shall be tested as specified herein.
- G. Provide reducing fittings for changes in pipe sizes.
- H. Cleaning: as specified in Section 231000, Piping, Valves and Accessories.

3.2 UNDERGROUND CHILLED WATER SYSTEMS

- A. Plastic end covers shall not be removed until field joint is ready to be made.
- B. Immediately after installation in the ditch, a partial backfill shall be made in the middle of each length leaving joints exposed for inspection.
- C. At anchor locations, field-insulate exposed carrier pipe and seal to the protective jacket per manufacturer's recommendations.

- D. Concrete anchor blocks shall be cast over the anchor plates and piping. The concrete shall be 30" minimum length and shall extend a minimum of 12" beyond the top and bottom of each anchor plate.
- E. After anchor blocks are poured and cured, a hydrostatic test of 150 psig shall be required for a period of 4 hours.
- F. After hydrostatic test, a backfill of selected earth shall be hand placed and hand tamped in 4" layers to 12" minimum over the top of the jacket. Remainder of the backfill shall be free of rocks over 6" in diameter, frozen earth or foreign matter, and shall be completed in accordance with Division 31, Earthwork, with the exception that tracked or wheeled vehicles shall not be used for tamping.
- G. Minimum bury depth for preinsulated piping system mains shall be 4' to top of outer jacket. Minimum bury depth for preinsulated piping system branches to buildings shall be 3' to top of outer jacket.
- H. Unload, install, and test under the supervision of a factory installation supervisor. On completion of the installation, submit a certificate from the manufacturer stating that the installation has been accomplished in accordance with the manufacturer's recommendations.

3.3 FLANGES

- A. Provide flanges for disconnecting pipe from valves and as indicated on the Drawings.

3.4 WATER SUPPLY AND RETURN PIPING

- A. Arrange piping for the venting of air and for drainage of the entire system.
- B. Changes in size of vertical piping shall be made with concentric reducers, and in horizontal piping, shall be made with eccentric reducers to maintain uniform top elevation of pipe.

END OF SECTION 231500

SECTION 232500 – HVAC INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other HVAC systems are specified in other Sections of Division 23.
- B. This Section covers thermal insulation for equipment, ductwork and piping specified in Division 23.
- C. Items not to be insulated:
 - 1. Piping installed in enclosures for:
 - a. Unit ventilators.
 - b. Unit heaters.
 - c. Finned tube radiation.
- D. This Section includes responsibilities and obligations in support of the performance verification specified in Section 230090, HVAC Performance Verification, and commissioning specified in Section_____.

1.2 DEFINITIONS

- A. Exterior piping, ductwork, or equipment is exposed to outdoor temperature.

1.3 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. North Carolina State Energy Conservation Code-2018.
 - 2. North Carolina State Mechanical Code-2018.
- B. Products of the manufacturers listed will be acceptable for use for the specific functions specified herein. Materials shall be compatible with the materials to which they are applied, and shall not corrode, soften or otherwise attack such material in either the wet or dry state.
- C. Materials shall be applied subject to their temperature limits. Methods of application of insulating materials or finishes not specified in detail herein shall be in accordance with the particular manufacturer's published recommendations.
- D. Insulation shall be applied by experienced workers regularly employed for this type of work.

1.4 RATINGS

- A. Insulation and accessories, unless specifically excepted herein, shall have a maximum composite flame spread rating of 25 and a maximum smoke developed rating of 50. Materials that are factory-applied shall be tested as assembled. Materials which are field-applied may be tested individually. No fugitive or corrosive treatments shall be employed to impart flame resistance.
- B. Flame spread and smoke developed ratings shall be in accordance with ASTM E84-2019b. Products or their shipping cartons shall bear a label indicating flame spread and smoke developed ratings.

- C. Treatment of pipe jackets and duct facings to impart flame and smoke safety shall be permanent. The use of water-soluble treatments is prohibited.
- D. Vapor retarders shall have a maximum permeance of 0.02 perm at 73.4°F.

1.5 ALTERNATE THICKNESSES

- A. Specified thicknesses may be increased or reduced for insulation materials having thermal resistivity, K-values, different from those listed. Submit calculations in accordance with ASHRAE/IES 90.1-2019, and documentation of product performance.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Fiberglass Pipe, Duct and Equipment Insulation:
 - 1. Maximum K-value for preformed pipe insulation: 0.23 Btu·in/(h·ft²·°F) at 75°F.
 - 2. Maximum K-value for board insulation: 0.23 Btu·in/(h·ft²·°F) at 75°F.
 - 3. Minimum R-value for blanket insulation shall be as specified herein and shall be based on an installed condition with 25% compression of the specified nominal thickness at 75°F.
 - 4. Pipe and board insulation for steam piping and hot water piping, except low temperature hot water, shall have maximum service temperature of 850°F. Insulation for other services shall have maximum service temperature not less than 250°F.
 - 5. Pipe and board insulation for hot equipment shall be designed for operating temperatures up to 850°F.
 - 6. Manufacturer: CertainTeed, Johns Manville, Knauf, Owens Corning, or Manson Insulation.
- B. Adhesives, Sealants, Coatings, and Mastics:
 - 1. Vapor barrier mastic (white) for below ambient pipe and duct service only. Water vapor permeance shall comply with ASTM E96/E96M-2016, 0.08 perms or less at 45 mils dry.
 - a. Manufacturer: Childers CP-34, Foster 30-65, or Vimasco 749.
 - 2. Lagging adhesive and coating.
 - a. Manufacturer: Childers Chil-Seal CP-50A MVI, Foster 30-36 Sealfas, or Vimasco 136.
 - 3. Insulation joint sealant for cellular glass, phenolic, and polyisocyanurate.
 - a. Manufacturer: Childers Chil Byl CP-76, Foster Flextra 95-50, or Pittsburgh Corning Pittseal CW.
 - 4. Elastomeric adhesive.
 - a. Manufacturer: Armaflex 520 BLV, Childers CP-82, Foster 85-75, or Kflex 720-LVOC.
 - 5. Elastomeric insulation coating.
 - a. Manufacturer: Armacell WB Finish, or Kflex 374.
 - 6. Aluminum jacketing sealant, and flexible butyl elastomer based vapor barrier sealant.
 - a. Manufacturer: Childers Chil-ByL CP-76, Foster 95-44, or Pittsburgh Corning PC 444N.
- C. Preformed Fittings:
 - 1. Equal thickness and composition to adjacent pipe insulation.
 - 2. Manufacturer: Extol, Performance Insulation Fabricators, or Specialty Products & Insulation.

- D. Insulating Cement:
 - 1. Mineral wool type, asbestos free, maximum K-value of 0.20 Btu·in/(h·ft²·°F) at 75°F.
 - 2. Manufacturer: Industrial Insulation Group CalCoat-127, or Ramco Ramcote 1200.
- E. Cellular Glass:
 - 1. Maximum K-value: 0.29 Btu·in/(h·ft²·°F) at 75°F.
 - 2. Manufacturer: Pittsburgh Corning Foamglas.
- F. PVC Fitting Covers:
 - 1. Preformed insulated PVC covers for pipe fittings. Insulation thickness shall match adjacent piping, and shall be increased to limit insulation outer surface temperature to 150°F.
 - 2. Manufacturer: Johns Manville Zeston 2000, Proto Corporation, or Speedline Corporation.
- G. Flexible Elastomeric Sheet, Tubing and Tape:
 - 1. Closed-cell.
 - 2. Maximum K-value: 0.25 Btu·in/(h·ft²·°F) at 75°F.
 - 3. Manufacturer: Aeroflex Aerocel, Armacell AP Armaflex, or K-flex.
- H. Mineral Wool:
 - 1. Maximum K-value: 0.28 Btu·in/(h·ft²·°F) at 75°F.
 - 2. Maximum service temperature: 1200°F.
 - 3. Manufacturer: Fibrex, Johns Manville, Owens Corning, or Rock Wool.
- I. Polyisocyanurate:
 - 1. Maximum aged 180-day K-value: 0.19 Btu·in/(h·ft²·°F) at 75°F.
 - 2. Minimum density: 2 pcf.
 - 3. Manufacturer: Hitherm HT 300, or ITW Trymer 25-50.
- J. Phenolic:
 - 1. Maximum K-value: 0.18 Btu·in/(h·ft²·°F) at 75°F.
 - 2. Minimum density: 2.5 pcf.
 - 3. Manufacturer: ITW Trymer Supercel, or Resolco International Insul-phen.
- K. Glass fabric: 10 x 10 construction white fiberglass scrim fabric.
- L. Tape: pressure sensitive, foil-scrim-kraft backed.
- M. Staples: outward clinching type.
- N. Rigid inserts: cellular glass or 5 pcf phenolic. Rigid inserts shall be same length as insulation protectors, 360° pipe coverage, and same thickness as adjacent insulation. Where polyisocyanurate is specified herein, rigid inserts may be polyisocyanurate, minimum 2 pcf for piping 6" and smaller and minimum 3 pcf for pipe 8" and larger. Where fiberglass is specified herein, rigid inserts may be premolded minimum 20 pcf fiberglass blocks with 180° pipe coverage. Where flexible elastomeric is specified herein, rigid inserts may be rigid foam designed for the supported weight without compression. Provide jacketing, joint sealing, and weatherproofing as specified for the pipe service. Fiberglass inserts shall be selected for a maximum 10% compression when loaded. Polyisocyanurate inserts shall be selected such that compressive load does not exceed 33% of the compressive strength of the insert.

PART 3 - EXECUTION

3.1 GENERAL

- A. Surfaces to be insulated shall be clean, dry, and free of foreign material, rust, scale and dirt when insulation is applied. Perform pressure and leakage tests and submit results required by other Sections before applying insulation.
- B. Where existing insulation is damaged due to the new work, repair damage to match existing work or replace damaged portion with insulation specified for new work.

3.2 MATERIAL SELECTIONS

- A. Where multiple insulation materials are specified herein for the same service, one of the specified materials shall be applied and used consistently throughout the project, subject to the requirements of these specifications.

3.3 INSULATION FOR COLD PIPE

- A. Insulate the following pipe with preformed phenolic or polyisocyanurate pipe insulation of the thickness indicated with a vapor retarder and all service jacket with self-sealing lap:

	<u>Insulation Thickness, Inches</u>		
	<u>Through 1.25".</u>	<u>1.5" - 12"</u>	<u>14" and over</u>
Chilled water supply and return, except as specified herein	1	1.5	1.5
	0.5	0.5	0.5
Exterior chilled water supply and return	1	1.5	1.5

1. Seal longitudinal and end joints with sealant and mastic as recommended by the manufacturer to achieve the permeance rating specified herein. Install insulation with jacket drawn tight with side-laps and end joint butt strips secured. End joint butt strips shall be same material as jacket, not less than 3" wide.
 2. Insulate fittings, flanges, strainers, unions, and valves with preformed or mitered phenolic or polyisocyanurate fitting sections. Secure fittings in place, seal joints and contour mitered sections with insulating cement, and finish with a layer of glass fabric embedded between 2 coats of vapor barrier mastic. Glass fabric shall overlap adjoining insulation at least 2".
 3. Where temperature maintenance cable is specified herein or indicated on the Drawings, piping shall be insulated after application of temperature maintenance cable.
 4. Provide vapor stops consisting of glass fabric and vapor barrier mastic over the entire end of butt joints at control valves, strainers, and equipment requiring access.
- B. Insulate the following pipe with preformed cellular glass pipe insulation of thickness indicated with a vapor retarder and all service jacket with self-sealing lap:

	<u>Insulation Thickness, Inches</u>	
	<u>Pipe Sizes</u>	
	<u>Through 1.25"</u>	<u>1.5" and over</u>
Chilled water supply and return, except as specified herein	1.5	2
Exterior chilled water supply and return	1.5	2
1.	Seal longitudinal and end joints with sealant and mastic. Install insulation with jacket drawn tight with side-laps and end joint butt strips secured. End joint butt strips shall be same material as jacket, not less than 3" wide.	
2.	Insulate fittings, flanges, strainers, unions, and valves with preformed or mitered cellular glass fitting sections. Secure fittings in place, seal joints and contour mitered sections with insulating cement, and finish with a layer of glass fabric embedded between 2 coats of vapor barrier mastic. Glass fabric shall overlap adjoining insulation at least 2".	
3.	Where temperature maintenance cable is specified herein or indicated on the Drawings, piping shall be insulated after application of temperature maintenance cable.	
C.	Insulate the following pipe with preformed flexible elastomeric insulation 1.5" thickness:	
	Refrigerant suction. Refrigerant liquid. Condensate drain.	
1.	Insulation shall be slipped on before pipe joints are completed. Hold back from hot joints until cool. Cement insulation joints with adhesive applied to both ends.	
2.	Insulate fittings, flanges, unions, and valves with fabricated fittings, same thickness as piping.	
3.4	INSULATION FOR COLD EQUIPMENT	
A.	Insulate chilled water pumps with 1" thick flexible elastomeric sheets. Insulation shall be adhered to inside of 18 gauge aluminum casings. Casings shall be fabricated in a minimum of 2 sections, with flanged and bolted joints or operable latches and hinges. Hardware shall be galvanized or cadmium-plated steel. Casings shall be designed for removal to allow access for maintenance without damaging insulation. Seal penetrations of casings.	
B.	Insulate chilled water expansion tanks, chilled water buffer tanks, and inline air separators as specified herein for chilled water pipe.	
C.	Insulate chilled water piping appurtenances, thermowells, thermometer test wells, gauge cocks, valve stems, and hangers and supports subject to sweating with flexible elastomeric tape.	
3.5	INSULATION FOR DUCT SYSTEMS	
A.	Insulate the following concealed duct systems with flexible, fiberglass insulation, nominal 2.2" thickness, minimum R-value at the installed condition of 6.0 h·ft ² ·°F/Btu, with foil-scrim-kraft facing:	
	Supply ductwork and plenums. Outside air ductwork and plenums. Mixed air ductwork and plenums. Intake, exhaust and relief plenums.	

Surfaces of diffusers exposed to unconditioned or indirectly conditioned spaces.

1. Overlap edges 3" and secure 12" on center with copper-clad, stainless steel or galvanized steel wire.
2. Seal joints, breaks, and punctures with tape.
3. On ducts over 24" wide, insulation shall be secured to the underside with mechanical fasteners maximum 18" on center each way.
4. Insulation shall be installed with 25% or less compression of the nominal thickness.

- B. Insulate the following exposed duct systems with 2" thick rigid fiberglass board, 3pcf minimum density, with foil-scrim-kraft facing:

Supply ductwork and plenums.
Outside air ductwork and plenums.
Mixed air ductwork and plenums.
Intake, exhaust and relief plenums.

1. Secure with welded pins or clips set in adhesive 18" on center each way with 2 rows per panel minimum.
2. Seal joints and clips with tape.
3. Finish insulation with glass fabric, set in white lagging adhesive.

3.6 INSTALLATION

- A. Insulation shall be clean and dry during installation and during application of any finish.
- B. Provide removable and replaceable covers on pumps, equipment, and removable ends of strainers requiring insulation that must be opened periodically for inspection, cleaning, or repair.
- C. Install insulation materials with smooth and even surfaces, jackets drawn tight and cemented down smoothly at longitudinal and end laps. Do not use scrap pieces of insulation where a full length section will fit.
- D. Install insulation, jackets and coatings continuous through openings and sleeves in nonrated construction. For penetrations of fire- or smoke-rated construction, insulation shall be butted tightly against firestops specified in Section 230010, HVAC General. Tape and seal butt joints.
- E. Banding wires shall have the twisted terminals turned down toward the insulation without damaging the vapor barrier.
- F. Install layered insulation with layer joints staggered. Wire inner layer 9" on center; apply outer layer and finish as specified herein.
- G. Finish open ends of pipe insulation as specified herein for fittings.
- H. Provide rigid inserts at each insulation protector location for piping 1.5" and larger.
- I. Fill hollow steel pipe covering protection saddles with fiberglass insulation.
- J. Standing seams and projections in ductwork or casings shall have insulation applied so that at least 0.25" of insulation will cover such projections.
- K. Lined Ductwork:
1. Where ductwork and plenums are lined, no external thermal insulation is required
 2. Where lining is interrupted at dampers and heating coils, insulate ductwork.
 3. Where unlined duct and lined duct connect, the insulation shall overlap lined section at least 4".

- L. Insulation and vapor barrier shall be continuous around and under standoff brackets used for mounting balancing and control devices on ductwork.
- M. Where equipment is furnished with other components and adjoining piping factory-assembled on a skid or other common platform, such equipment and piping shall be insulated as specified herein.

3.7 WEATHERPROOFING

- A. Protect insulation on ductwork and equipment exposed to weather outside the building with self-adhering flexible exterior covering. Junctions of horizontal and vertical surfaces shall have a minimum of 3" vertical overlap. Horizontal seams shall have a minimum of 6" overlap in roof shingle fashion. Install as recommended by the manufacturer.
- B. Protect insulation, except flexible elastomeric, on piping exposed to weather outside the building with 0.016" thick corrugated aluminum jacketing with factory-applied moisture retarder protective film on the inner surface. Provide 2" overlap at joints with sealant as recommended by the manufacturer. Locate longitudinal joints to shed water. Secure jacketing with aluminum bands every 12" and at end joints.
- C. Protect exterior flexible elastomeric insulation with UV resistant white acrylic latex coating.

END OF SECTION 232500

SECTION 236000 - EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other HVAC systems are specified in other Sections of Division 23.
- B. This Section covers HVAC systems and equipment.
- C. Testing, adjusting and balancing is specified in Section 230095, Testing, Adjusting and Balancing.
- D. This Section includes responsibilities and obligations in support of the performance verification specified in Section 230090, HVAC Performance Verification, and commissioning specified in Section _____.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. North Carolina State Electrical Code-2017.
 - 2. North Carolina State Energy Conservation Code-2018.
 - 3. North Carolina State Mechanical Code-2018.
- B. Pressure/temperature ratings of components and accessories shall meet or exceed design conditions for the system in which they are installed. Refer to Section 231000, Piping, Valves and Accessories, and requirements specified herein.
- C. Provide a complete parts and labor warranty, including refrigerants and lubricants, for 1 year after date of substantial completion, for the following equipment:
 - 1. Air-cooled chillers.
 - 2. Rooftop air conditioning units.

PART 2 - PRODUCTS

2.1 COILS

- A. Copper tubes, and nonferrous fins with belled collars mechanically bonded to the tubes.
- B. Cooling coils: 0.024" wall thickness and 0.009" fin thickness, designed for counterflow of water to air.
- C. Multirow hot water coils: designed for parallel flow of water to air.
- D. Supply and return connections shall be on the same end.
- E. Performance shall be in accordance with AHRI 410-2001 (with Addendum).
- F. Minimum working pressure rating shall be equal to that specified herein for the piping system in which the coil is installed. Coils shall be tested at the rated working pressure plus 50%.

2.2 AIR-COOLED CHILLERS

- A. Packaged, air-cooled type, designed and constructed in accordance with ASHRAE 15-2019, complete with refrigerant, compressors, motors, evaporator, condenser, insulation, controls, motor controller, control panel, mounting base, enclosure, and associated equipment. Enclosures constructed of steel shall be protected with a flexible epoxy coating.
- B. Rating certification: capacity rating shall be certified in accordance with AHRI 550/590-2018 (Errata). Submit chiller performance data directly from the manufacturer's selection software annotated with a statement of AHRI compliance and including software version number, chiller model number, refrigerant, net refrigeration capacity, water flow rate, pressure drop, entering and leaving water temperatures, power input, ambient condition, fouling factors, and voltage. Performance shall be provided at the full load design condition and each of the NPLV part load conditions.
- C. Compressors shall be one of the following types:
 - 1. Scroll type, including centrifugal oil pump. Compressors shall cycle to meet demand. Chillers greater than 35 tons shall have a minimum of 2 refrigerant circuits.
 - 2. Digital scroll type, including solenoid valve and variable cycle time to allow continuous capacity reduction from 100% to 10% load.
 - 3. Rotary screw type, complete with positive pressure oil lubrication system, oil heater, and automatic capacity reduction system with automatic unloading on start-up. Compressors shall fully modulate from 100% to 10% of design capacity.
- D. Evaporators: shell and tube or brazed-plate constructed for 150 psig waterside rating, covered with 1.5" thick flexible elastomeric sheet, vapor barrier insulation; protected against freeze-up by a thermostat-controlled temperature maintenance cable wrapped around the shell under the insulation. Fouling factor shall be $0.0001 \text{ ft}^2 \cdot ^\circ\text{F} \cdot \text{h/Btu}$.
 - 1. Evaporators for variable chilled water flow shall be certified by the manufacturer to operate with the minimum chilled water flow indicated on the Drawings.
- E. Refrigerant circuits: high side pressure relief valve, service isolation valves, filter drier, moisture indicating sight glass, liquid line solenoid valves, insulated suction lines, and thermal expansion valves.
- F. Condensers: vertical discharge with safety guard. Coils shall have copper tubes and aluminum fins, or single piece aluminum construction.
 - 1. Entire coil, including tubes, fins, and frame shall be coated with a flexible epoxy material by an immersion process and UV protection topcoat.
- G. Motor controllers: wye-delta motor starter or variable frequency drive. Controllers and components, excluding evaporator heater, shall be factory-wired for a single-point field power connection.
 - 1. Controllers shall include:
 - a. Non-fused disconnect switch or non-automatic circuit breaker, with door interlocked externally-operable handle, capable of being pad locked. Electrical lugs shall be sized for the incoming power wiring.
 - b. Short-circuit rating of 36,000 A.
 - c. Control power transformers for controls and accessories.
 - d. Short circuit, motor overload, and ground fault protection.
 - e. Phase failure and low voltage protection.
 - 2. Variable frequency drives shall include harmonic filters to limit total demand distortion from current and the total harmonic distortion from voltage each to a maximum of 5% at the input terminal of the variable frequency drive. Coordinate with the supplier of other variable frequency drives on this project and provide data for a harmonic analysis performed in accordance with IEEE 399-1997.

- H. Control panels: unit-mounted in a weather-tight enclosure with microprocessor-based operating and safety controls, graphic display and keypad, with monitoring capabilities, programmable setpoints, and building control system interface. Panels shall include the manufacturer's standard control package with accessories as required to provide the following functions:
1. Leaving chilled water temperature control.
 2. Graphic display of the following items, including factory-wired devices and sensors:
 - a. Chilled water temperature entering and leaving evaporator.
 - b. Evaporator refrigerant pressure and temperature.
 - c. Condenser refrigerant pressure and temperature.
 - d. Ambient temperature.
 - e. Oil pressure.
 - f. Oil temperature.
 - g. Motor current % of rated load amperes.
 - h. Input power (kW).
 - i. Operating hours.
 - j. Diagnostic messages.
 3. Communication interface to transmit operating data and receive commands through a single connection to the building control system. The interface shall include hardware and software coordinated with the building control system that allows monitoring and control of data and alarms available at the control panel from the BCS. Communication protocol shall be BACnet, LonWorks, or Modbus as coordinated with the building control system supplier. Information transmitted and received shall include:
 - a. Digital inputs from the building control system:
 - 1) Chiller enable/disable.
 - b. Analog inputs from the building control system:
 - 1) Chilled water reset.
 - 2) Electric power demand limit.
 - c. Digital outputs to the building control system:
 - 1) Chiller status.
 - 2) Chiller master alarm indicating shutdown due to safety controls.
 - d. Analog outputs to the building control system:
 - 1) Running amperes as a percentage of rated load amperes.
 - 2) Chilled water setpoint.
 - 3) Current limit setpoint.
- I. Evaporator differential pressure switches: opposed-diaphragm type, with magnetically actuated adjustable switches, dial type differential pressure readout, and isolation and null valves, selected to operate in the top 80% of the range at the differential pressure corresponding to minimum allowable evaporator flow. Switch shall not drop out at differential pressures that exceed the range. Maximum line pressure shall exceed the operating pressure of the installed system.
1. Manufacturer: Orange Research 1516 DGS series.
- J. Enclosures: factory-mounted louvered panels which shall completely screen from view and protect condenser coils.
- K. Chiller manufacturer shall coordinate and approve controls provided in Section 238000, Automatic Temperature Controls, and shall indicate such approval in writing on the control shop drawing submittal.

- L. Written instructions and control diagrams showing wiring and programming for building control system interfaces shall be furnished by the manufacturer to be incorporated in the control diagrams specified in Section 238000, Automatic Temperature Controls.
- M. Manufacturer: Daikin, Trane, or York.

2.3 TERMINAL UNITS

- A. Casings:
 - 1. Minimum 24 gauge galvanized steel.
 - 2. Acoustical lining: minimum 0.5" thick, 1.5 pcf density coated fiberglass. Lining shall meet erosion test method described in UL 181-2013 and shall have a flame spread rating of not more than 25 and a smoke developed rating of not more than 50 in accordance with NFPA 90A-2018.
 - 3. Access doors: sealed, flush type for access to internal parts for service or maintenance.
 - 4. Enclosure: removable type for control components.
 - 5. With four angle or heavy gauge hanger brackets for units indicated on the Drawings to be suspended with vibration isolators.
 - 6. Casing leakage rate of less than 3% at 4" wg.
 - 7. Inlet velocity shall not exceed 2200 fpm.
- B. Control Motors:
 - 1. Factory-installed on units by unit manufacturer.
 - 2. Coordinated with automatic control system manufacturer; see Section 238000, Automatic Temperature Controls.
- C. Airflow sensors: averaging multipoint type, with taps for field calibration, minimum $\pm 5\%$ accuracy with 90° elbow at inlet.
- D. Volume Regulators:
 - 1. Factory preset: minimum and maximum air quantity. Air volumes and unit size shall be indicated on the regulator.
 - 2. Gauge taps and calibrated means of adjustment to permit field adjustment of air quantities without unit disassembly.
 - 3. Pressure independent, capable of maintaining constant volume, $\pm 5\%$, up to 4" wg inlet air pressure.
 - 4. Factory-mounted.
 - 5. Removable.
- E. Depth of units: 20" maximum.
- F. Moving parts designed for minimum of 300000 cycles.
- G. Heating Coils:
 - 1. Electric, labeled as a complete assembly with the terminal unit per UL 1995-2015 or ETL listed to comply with the requirements of UL 1995-2015, complete with unit-mounted terminal box with hinged cover, silicon controlled rectifier (SCR) controls, and intermediate coil supports.
 - 2. Heating elements, exposed element type:
 - a. Nickel chrome (80% nickel, 20% chrome) coiled wire, with minimum 1 wire diameter open space between adjacent coils.
 - b. Maximum wire density: 37 W/in².
 - c. Maximum wire surface temperature: 1400°F.

3. Coils rated more than 48 A shall have heating elements subdivided. Each subdivided load shall not exceed 48 A and shall be fuse protected.
 4. Provide a wiring diagram showing terminal designations of power and control circuits, mounted inside the terminal box.
 5. Integral terminal boxes shall include:
 - a. Terminal blocks for line feeder and control connections.
 - b. Incoming line fuses for ungrounded conductors.
 - c. Control circuit transformer with fused primary 24 V secondary unless otherwise specified herein.
 - d. Automatically reset thermal cutouts for primary over-temperature protection.
 - e. Manually reset thermal cutouts, load carrying type, for secondary over-temperature protection.
 - f. Contactors. Controlling and back-up contactors shall be magnetic. Back-up contactors shall break ungrounded conductors.
 6. Controls:
 - a. Coil shall be interlocked with fan by pressure differential air flow switch.
 - b. Analog input for modulating control of SCR heating.
 - c. Steps of heat shall be operated with contactors.
- H. Sound Power Level Performance:
1. Terminal unit casing radiated and discharge sound power levels shall be tested in accordance with AHRI 880-2017 and shall be certified by AHRI.
 2. Maximum allowable casing radiated and discharge sound power levels are scheduled on the drawings.
 - a. If needed to achieve the scheduled discharge sound power levels, the manufacturer may provide supplemental sound attenuators at the unit discharge and, in the case of fan-powered terminal units, at the unit's plenum return opening(s). Calculations demonstrating the overall terminal unit and attenuator(s) assembly performance shall be provided with the equipment submittal.
- I. Variable Volume Units:
1. Complete with:
 - a. Air valve assembly, normally open.
 - b. Variable air volume from maximum of 100% to minimum of approximately 0%.
 - c. Units shall be factory-wired for a single electrical connection point, including input fuses, single disconnect switch for heating coil, and transformers.
- J. Fan-Powered Units:
1. Complete with:
 - a. Air valve assembly, type as indicated on the Drawings.
 - b. Parallel type: air valve and fan in parallel with backdraft damper on fan, and baffles to prevent stratification. Intermittent fan operation.
 - c. Series type: air valve and fan in series. Constant fan operation.
 - d. Forward-curved fan with positive means of volume control.
 - e. 1" thick throw away filter and clips on return air opening.
 - f. Permanent lubricated split capacitor 3-speed motor with speed changing taps or permanent lubricated motor with electronic speed controller, thermal overload protection, fan motor controller, transformer, disconnect switch, and wiring.
 - g. Units shall be factory-wired for a single electrical connection point, including input fuses, single disconnect switch for both fan and heating coil, and transformers.

K. Manufacturer: Johnson Controls, Krueger, Metal*Aire, Nailor, Price, Titus Trane

2.4 AIR HANDLING UNITS

A. General, except as otherwise specified herein:

1. AHU-1-1 can be a custom or modular AHU. The performance criteria must all be met below, as well as schedule and dimensioned on the drawings.
2. Complete with fan, motor, drive, coils, access sections, discharge plenum, and filters housed in a finished solid double-wall casing with thermal insulation and drain pan. Functional components shall be accessible for inspection and maintenance through hinged, solid double-wall access doors in each section. Piping connections shall extend through the casing. Unit performance for standard and modular units shall be certified in accordance with AHRI 430-2014 Addendum 1. Unit performance for custom units shall be ETL listed and labeled.
3. Fans:
 - a. Tested in accordance with ASHRAE 51/AMCA 210-2016.
 - b. Statically and dynamically balanced. Fans with variable frequency drives shall be dynamically balanced throughout the complete speed range.
 - c. Bearings: pillow block or flange type with L_{10} life of 80000 hours at the peak operating condition. Extend grease leads to allow lubrication during inspection on the access side.
 - d. For housed centrifugal fans in draw-through units, fan wheel rotation shall be in the same direction as flow in elbows installed within 3 duct diameters of the fan discharge, where discharge from the elbow is perpendicular to the fan shaft.
4. Cooling coils: chilled water type, as specified in Paragraph 2.1, Coils.
5. Heating coils: electric type, as specified in Paragraph 2.11, Electric Heating Coils.
6. Filters: bag type, as specified in Section 237000, Air Distribution.
7. Internal vibration isolation: at Contractor's option, internal vibration isolators may be provided in lieu of external isolators. Fan and motor shall be mounted on a common steel vibration base. Fans shall have a flexible connection to the casing. Internal vibration isolators shall be as specified in Section 230010, HVAC General, and as indicated on the Drawings.
8. Drives: V-belt type, as specified in Section 237000, Air Distribution.
9. Motors: as specified in Section 230010, HVAC General.
10. Variable frequency drives: as specified in Section 230010, HVAC General.
11. Control dampers: as specified in Section 238000, Automatic Temperature Controls.
12. Drain pans: double-wall stainless steel construction with insulation sandwiched between inner and outer pans. Corners shall be welded. Pans shall be pitched toward drain outlet. Units with stacked coils shall include a secondary drain pan under each coil with drain piping to main pan.
13. Double-wall casing insulation: 2" thick spray injected foam with a maximum K-value of 0.167 Btu·in/(h·ft²·°F) at 75° F. Insulation shall have a composite flame spread rating of not more than 25 and a smoke developed rating of not more than 50 in accordance with NFPA 90A-2018.
14. The following coastal requirements shall be provided for air handling units AHU-1-1
 - a. Flexible epoxy coating for cooling coils.
 - b. Cooling coil sections with stainless steel hardware, including, but not limited to, tracks, liners, and tube sheets.
 - c. Fans with flexible epoxy coatings and stainless steel drive shafts.
 - d. Totally enclosed, fan-cooled motors.
 - e. Filter sections with stainless steel hardware, including, but not limited to, racks, frames and liners.
 - f. Flexible epoxy coating on exterior casings for roof-mounted units.

B. Other Draw-Through Type Units:

1. Manufacturer: Daikin, Johnson Controls/York Solution, or Trane.

C. Custom Type Units:

1. Custom type, with assembly of units not factory-assembled supervised and certified by the manufacturer.
2. Fans: protected against corrosion.
3. Bearings: pillow block or flange type with L_{10} life of 80000 hours at the peak operating condition.
4. Sound power levels, in dB re 10^{-12} watts, at inlet or outlet duct connections and adjacent to unit in equipment room, at maximum rated conditions, as determined in accordance with AHRI 260-I-P 2017, shall not exceed the following values:

	Frequency (Hz)				
	125	250	500	1000	2000
Outlet/inlet connections					
Casing radiated					

5. Internal vibration isolation: fan and motor shall be mounted on a common steel vibration base, mounted on vibration isolators, as specified in Section 230010, HVAC General, and as indicated on the Drawings. Fans shall have a flexible connection to the casing.
6. Filters: bag type, as specified in Section 237000, Air Distribution.
7. Control dampers: where indicated on the Drawings, and as specified in Section 238000, Automatic Temperature Controls.
8. Smoke, dampers: where indicated on the Drawings, and as specified in Section 237000, Air Distribution.
9. Casings: designed to withstand 10" wg positive and negative pressure with maximum 1% leakage and maximum 0.25" deflection in 10' span. Floor construction shall include structural reinforcement to support internal equipment plus two 250 lb maintenance workers in each plenum. Panels shall be 4" thick with 18 gauge galvanized exterior sheeting and 22 gauge solid inner liner. Insulation shall be 4" thick spray injected foam with a maximum K-value of 0.167 Btu·in/(h·ft²·°F) at 75° F. Insulation shall have a composite flame spread rating of not more than 25 and a smoke developed rating of not more than 50 in accordance with NFPA 90A-2018. Inner surfaces shall be smooth and accessible for cleaning. Provide hinged, double-wall access doors with view windows on each side of each service plenum and at locations indicated on the Drawings. Provide sleeves through casing wall for piping, wiring and controls. Hardware, fasteners and miscellaneous materials shall be corrosion resistant. Assembled unit or each section of sectional units shall be provided with lifting lugs.
10. Drain pans: constructed of type 304 stainless steel, sloped to provide positive self-drainage, with drain opening easily accessible for cleaning. Units with stacked cooling coils shall include a secondary drain pan under each coil with drain piping to main pan. Drain pans shall extend upstream and downstream as necessary to prevent wetting of service plenums or carryover of moisture droplets at 450 fpm cooling coil face velocity. Provide auxiliary drain pans or flashing to prevent wetting of unit floor from condensation on cooling coil return bends, piping or other cold surfaces within the unit.
11. Floor construction: 12 gauge steel, corrosion protected after fabrication, with nonskid walking surface.
12. Washdown plenums: inner liner in plenums upstream and downstream of cooling coils shall be 22 gauge solid stainless steel, with drain for washdown.
13. Access doors: 18 gauge inner and outer panels, overlapping seal type with double continuous air/acoustic seals around the sill, jambs, and head. Minimum of 2 wedge lever type latches and 3 butt or ball bearing offset type hinges per door.
14. Coil piping: from cooling coils to connection point outside the exterior casing, with flange or union at each coil connection and vent and drain valves at each coil inside the unit.
15. Marine lights: in each service plenum, with switch and indicator light at each door.
16. Electrical utility outlets: weatherproof GFCI type in each equipment service plenum and on each side of the exterior casing.
17. Fan vibration safety switches: at each fan, arranged to stop fan operation and alarm through the BCS and energize a warning light outside the fan plenum.

18. Control damper actuators: as specified in Section 238000, Automatic Temperature Controls.
19. Other control system components: install control devices located within the casings, as described in Section 238000, Automatic Temperature Controls. Coordinate type and characteristics of devices with the controls subcontractor.
20. Electric control wiring: termination panels with terminal strips on exterior of casing, with wiring to each sensor and control component located within the unit. Wiring shall be in accordance with Section 238000, Automatic Temperature Controls.
21. Electric power wiring: from fan motors, marine lights, to junction boxes on exterior casing. Wiring shall be in accordance with Division 26.
22. Manufacturer: Buffalo, , Governair, Johnson Controls/York Solution Custom, or Environmental Air Systems

2.5 DUCTLESS SPLIT SYSTEMS

- A. Systems shall be commercial grade equipment, complete with an outdoor condensing unit, indoor fan-coil unit, refrigerant piping, and controls. Units shall be rated in accordance with AHRI 210/240-2017. Units shall be factory-charged with refrigerant R-410A. Systems shall operate as cooling only systems as indicated on the Drawings.
- B. Outdoor condensing units: factory-assembled, complete with compressors, condenser fans, condenser coils, motors, controls, electronic expansion valves, solenoid valves, distribution headers, capillaries, filters, shut off valves, oil separators, service ports, refrigerant regulators, and controls.
 1. Compressors shall be variable speed scroll type. Compressor speed shall be varied between 5% to 100% speed in response to load variation. Compressors shall be equipped with crankcase heaters, high pressure safety switches, and internal thermal overload protection.
 2. Condenser fans shall be propeller type with variable speed digitally commutating motors.
 3. Condenser coils shall have copper tubes, and aluminum fins.
 4. Controls: microprocessor-based.
 5. Electric connections: single point 208 V, 3-phase.
- C. Indoor Fan-Coil Units:
 1. Ductless wall mounted type, factory-assembled complete with cabinet, fan, coil, air filter, condensate pan, integral condensate pump, and controls. Units shall be provided with supply and return grilles and shall be designed for installation on wall in a conditioned space.
 2. Filters: throw away type, as specified in Section 237000, Air Distribution.
 3. Controls: microprocessor-based.
 4. Electric connections: each fan-coil unit shall be single point connection.
- D. Refrigerant Piping:
 1. As specified in Section 231000, Piping, Valves and Accessories.
 2. Piping joints and headers shall be provided by the system manufacturer in order to provide balanced refrigerant flow, and to provide specified capacity and performance.
- E. Wall-mounted space temperature sensors: provide for all indoor fan-coil units with the following features:
 1. Thermistor type temperature sensor.
 2. Setpoint adjustment buttons.
 3. Backlit LCD display in English.
 4. Display of sensed room and set point temperatures.
 5. cooling set point range limits.
 6. Unoccupied mode with independent cooling and heating setup and setback set points.
 7. Buttons shall be capable of being disabled by maintenance personnel.

- F. Manufacturer: Carrier, Daikin, Friedrich, JCI/York, LG, Mitsubishi, or Panasonic.

2.6 ROOFTOP AIR CONDITIONING UNITS

- A. Packaged, air-cooled, variable volume draw-through type, complete with hermetic compressors, cylinder unloaders, suction and discharge service valves, spring vibration isolators, compressor ambient lockout, crankcase heaters, oil sight glass, refrigerant sight glass, refrigerant drier, thermostatic expansion valves, pressure relief valve or fusible plug, time delay between successive starts of each compressor, suction accumulator, manually reset low oil pressure cutout for each compressor, liquid line valve for isolating refrigerant charge in condenser, motor overload protector and winding thermostats, refrigerant solenoid valves, air-cooled condenser coils with guards, condenser fans and motors, evaporator coils, fans, motors, extended fan grease connections, filter section, and high and low pressure safety controls.
- B. Casings: weatherproof, galvanized steel construction with baked enamel finish, and a flexible epoxy coating. Sections and components shall be accessible through hinged access doors with neoprene gaskets. Casings shall be double-wall with solid inner panels and insulated with 2" thick spray injected foam with a maximum K-value of 0.167 Btu·in/(h·ft²·°F) at 75° F. Insulation shall have a composite flame spread rating of not more than 25 and a smoke developed rating of not more than 50 in accordance with NFPA 90A-2018. Units shall be mounted on watertight curb units.
- C. Fans:
1. Tested in accordance with ASHRAE 51/AMCA 210-2016.
 2. Statically and dynamically balanced. Fans with variable frequency drives shall be dynamically balanced throughout the complete speed range.
 3. Bearings: pillow block or flange type with L₁₀ life of 80000 hours at the peak operating condition. Extend grease leads to casing exterior to allow lubrication during operation.
 4. In draw-through units with centrifugal fans, fan wheel rotation shall be in the same direction as flow in elbows installed within 3 duct diameters of the fan discharge, where discharge from the elbow is perpendicular to the fan shaft.
- D. Filters: Pleated type, as specified in Section 237000, Air Distribution.
- E. Dampers: as specified in Section 237000, Air Distribution.
- F. Condensers: selected for a condensing temperature not to exceed 120°F at 100°F ambient. Coils shall have copper tubes and aluminum fins, entire coil coated with a flexible epoxy.
- G. Variable volume features: variable frequency drives, as specified in Section 230010, HVAC General. Static pressure sensor for remote mounting in duct, and a static pressure controller mounted inside the unit control compartment, with a manahelic gauge connected to the static pressure sensing line and permanently mounted in an accessible location. Provide microprocessor-based leaving air temperature control including remote setpoint adjustment, adjustable reset rate (based on return air temperature), adjustable control band, and anti-frost control for the coil.
- H. Dry bulb temperature controlled economizer cycles: automatically modulated outdoor air damper, and fully modulated relief fan, in conjunction with refrigeration system controls, shall maintain space temperature. Relief fan shall be controlled and modulated in response to building pressure as sensed by a factory-installed differential pressure controller, set for 0.05" wg positive building pressure. Cycle shall be locked-out when outdoor temperature is too high for energy savings. Units shall have adjustable minimum position control and spring return damper.
- I. Constant outside air controls: automatically modulated return air damper to maintain mixing plenum static pressure as measured by a static pressure sensor in the mixed air plenum at the setpoint determined by the test and balance work shall maintain the minimum outside air quantity.

- J. Motors and starters: as specified in Section 230010, HVAC General.
- K. Remote readout panels: 7 day programmable type with 6 hour battery back-up. Panel shall show operation of system-fan-cooling-heating, and dirty filters.
- L. Night setback thermostat and guard.
- M. Sound attenuators: factory-installed, above the curb, fan discharge type, integral within the unit casing. Attenuators shall provide a minimum of 5 dB dynamic insertion loss in frequency range between 125 Hz and 500 Hz.
- N. Units shall be factory-wired to accommodate a single incoming main power feeder. Provide wiring diagram for isolating power circuit to evaporator fan, power burner and control circuit.
- O. Manufacturer: Carrier, Johnson Controls/York, or Trane.

2.7 WATER TREATMENT SYSTEMS

- A. Chilled Water Treatment Systems:
 - 1. Bypass chemical feeders: steel construction, 5 gal capacity, with a pressure rating of 125 psig. Tank shall have inlet, outlet, and fill cap with minimum 3.5" opening.
 - 2. Chemicals: shall conform to 21 CFR 173-2019.
 - 3. Supplier: Anderson, Garratt-Callahan, GE Water and Process Technologies, Nalco, National Chemical, Superior, or Technical Specialties.

2.8 PUMPS

- A. End-suction, split-case back pull-out type, bronze-fitted, flexible-coupled, with bronze-sleeved or stainless steel shafts, mechanical seals designed for the pump service, bronze casing and impeller wear rings, shaft and coupling guard, and one-piece bronze impellers of nonoverloading type so motor nameplate rating shall not be exceeded at any point on the pump curve up to 125% of the flow indicated on the Drawings. Impellers shall be statically, dynamically, and hydraulically balanced. Casings shall have drilled and tapped vent and drain holes and air vent cocks.
 - 1. Each pump and motor shall be mounted on a common base of welded steel construction with grout holes.
 - 2. Bearings: ball type, grease lubricated, with fittings, designed for in-service lubrication or sealed for life, rated for a L_{10} life of 50000 hours at the maximum load scheduled on the Drawings.
 - 3. Motors: as specified in Section 230010, HVAC General.
 - 4. Impeller diameter shall not exceed 95% of the maximum impeller diameter available for the pump selection.
 - 5. For chilled water applications: galvanized drain pan, 16 gauge minimum with a 0.5" drain coupling.
 - 6. Manufacturer: Allis-Chalmers, Buffalo, Crane-Deming, Ingersoll-Dresser, or Peerless.
 - 7. Manufacturer: Armstrong, Bell & Gossett, PACO, Patterson, Pentair-Aurora, Taco, or Weinman.

2.9 ELECTRIC WALL HEATERS

- A. UL listed, wall type. Heating elements shall be the tubular finned metal sheath type with helical coiled fins. Heaters shall have automatically reset thermal overheat protection, power disconnect device or positive off switch, and shall be factory wired for a single point connection including power disconnect.
- B. Complete with: direct-drive propeller fan and permanently lubricated motor. Motor shall be permanent split capacitor type with built-in automatically reset motor overload protection.

- C. Enclosures, surface-mounted, 20 gauge steel, with horizontal inlet and discharge grilles, baked enamel finish, color selected by the Architect.
- D. Controls: self-contained internally wired thermostat with remote bulb in return air.
- E. Manufacturer: Berko NFR, Brasch SR, INDEECO, Markel 3420, Q-Mark A, or Raywall.

2.10 ELECTRIC FINNED TUBE RADIATION

- A. General:
 - 1. Factory-assembled, wired and tested, UL listed.
 - 2. Designed to eliminate 60 Hz sound.
 - 3. High limit thermal cutout, automatic reset, linear full length type sensing bulb along entire length of heater. Self-contained thermostat for elements in each room.
 - 4. Disconnect switch.
 - 5. 2-stage control for 500 W/ft density and greater.
 - 6. Heating Elements:
 - a. Nickel chrome (80% nickel, 20% chrome) coiled wire imbedded in magnesium-oxide refractory material and enclosed in sheath. Spirally wound steel fins furnace brazed to steel sheath, or aluminum fins mechanically bonded to aluminum or steel sheath.
 - b. Heat-resistant nonoxidizing finish on sheath and fins. Copper-plated, high temperature aluminum finish, or ceramic coating for corrosion protection.
 - c. Maximum 6 fins per in.
 - d. Support anchor with cushioned space for expansion.
 - e. Maximum surface temperature: 350°F.
- B. Commercial Draft Barriers:
 - 1. Enclosures: 16 gauge steel.
 - 2. Grilles: louvered 16 gauge stamped steel or 14 gauge extruded aluminum.
 - 3. Finish: baked enamel, color as selected by the Architect.
- C. Architectural Draft Barriers:
 - 1. Enclosures: sloped top, minimum 16 gauge extruded aluminum.
 - 2. Grilles: minimum 16 gauge extruded aluminum.
 - 3. Finish: baked enamel, anodized, color as selected by the Architect.
 - 4. Provide pedestal mounts where indicated on the Drawings.
- D. Utility:
 - 1. Designed for mounting in a soffit, with heavy duty expanded metal guard.
- E. Manufacturer: Berko, Brasch, Electromode, Erincraft, INDEECO, Markel, Q-Mark, or Raywall.

2.11 ELECTRIC HEATING COILS

- A. UL listed, complete with terminal box with removable cover on the end of the coil, intermediate coil supports, automatically reset thermal cutouts for primary over-temperature protection, heat limiters or manually reset thermal cutouts for secondary over-temperature protection, and pressure differential airflow switch. Arrange circuiting to prevent stratification of hot and cold air.
- B. Heating elements: either sheathed or exposed element type.
 - 1. Sheathed Element Type:

- a. Nickel chrome (80% nickel, 20% chrome) coiled wire imbedded in magnesium-oxide refractory material and enclosed in sheath. Spirally wound steel fins furnace brazed to steel sheath, or aluminum fins mechanically bonded to aluminum or steel sheath.
 - b. Heat-resistant nonoxidizing finish on sheath and fins. Copper-plated, high temperature aluminum finish, or ceramic coating.
 - c. Maximum 6 fins per in.
 - 2. Exposed Element Type:
 - a. Nickel chrome (80% nickel, 20% chrome) coiled wire, with minimum one wire diameter open space between adjacent coils.
 - b. Maximum wire density: 37 W/in².
 - c. Maximum wire surface temperature: 1400°F.
 - C. Coil dimensions shall be the same as the duct in which installed or opening to which attached.
 - D. Coils rated more than 48 A shall have heating elements subdivided. Each subdivided load shall not exceed 48 A and each nongrounded conductor shall be fuse protected.
 - E. Integral control boxes shall contain a terminal block and terminals sized for single incoming power feeder; control circuit transformer with fused primary and fused 120 V secondary; 100000 cycle service, 3-pole line break contactor for each circuit and fuses, housed in a NEMA 1 enclosure.
 - F. Remote control cabinets shall contain a control circuit transformer with fused primary and 120 V secondary; 100000 cycle service, 3-pole line break contactor for each circuit; fuses for each circuit and separate terminal blocks and terminals for a single incoming power feeder and control circuits, housed in a NEMA 1 cabinet. Main busses and main lugs shall be sized for main feeder.
 - G. Energize contactors through pilot duty devices, PE switches and multistep thermostats up to 3 steps, step controllers for more than 3 steps. Step controllers shall recycle on power interruption.
 - H. Pipe pneumatic devices to bulkhead fittings on the side of the control box or cabinet.
 - I. Provide a wiring diagram showing terminal designations of power and control circuits, mounted inside the control box or cabinet.
 - J. Provide protective screens on entering and leaving air sides.
 - K. Manufacturer: Brasch, INDEECO, Markel HF, or Nailor.
- 2.12 CHILLED WATER BUFFER TANKS
- A. Vertical, steel construction, designed, constructed, certified, and stamped in accordance with ASME BPVC-VIII-1-2019 for 125 psig working pressure, with base ring or structural steel legs with baseplates.
 - B. Complete with manhole or inspection opening, air vent connection, lifting lugs, and bottom drain connection.
 - C. Tanks shall have a vertical internal baffle to prevent stratification. Piping connections shall be as indicated on the Drawings.
 - D. The exterior of the tanks shall be factory-painted with 2 coats of rust resisting paint.
 - E. Insulation: factory-applied 0.75" flexible elastomeric sheet secured with full coverage of adhesive.

- F. Insulation: field-applied, as specified in Section 232500, Insulation.
- G. Manufacturer: Cemline, Lochinvar, Reco, Taco, or Wessels, or Wheatley.

PART 3 - EXECUTION

3.1 CHILLERS

- A. Assembly shall be erected by trained mechanics in the employ of the manufacturer or under the supervision of an employee of the manufacturer in accordance with manufacturer's instructions.
- B. Provide ball valve on drain and vent connections on water boxes. Drain valves shall have hose end connections.
- C. Piping connections and control sequence shall conform to the manufacturer's specific requirements.
- D. Start-up service and commissioning shall be performed by mechanics retained by the manufacturer. Perform chiller commissioning and provide assistance and support during controls system commissioning. Submit a statement that the chillers are installed in accordance with the manufacturer's recommendations, and that safeties and controls are operating properly.
- E. Provide crossover pipe and connections between absorber and condenser shells of absorption chillers.
- F. Provide the services of a direct employee of the manufacturer to supervise the leak testing, evacuation, charging of the solution, and supervision of start-up.

3.2 TERMINAL UNITS

- A. Install terminal units with manufacturer's recommended upstream duct conditions for operation of velocity sensors and volume controls, and required clearances for control panels, coils, filters, return air openings, and other components.
- B. Install throw away filters while building is under construction. Upon completion of construction and final clean-up, remove these filters. and replace with a new set. and replace with 1" pleated filters.

3.3 AIR HANDLING UNITS

- A. For air handling units with coil sections that are near the floor, coordinate the unit mounting height with the condensate drain trap detail. If the bottom of the insulated drain trap conflicts with the floor slab, provide height adjustment supports between the air handling unit and housekeeping pad. Locate supports at manufacturer recommended load points.
- B. Custom units: units not factory-assembled shall be pressure tested in the field after installation. Unit casing leakage shall not exceed 0.5 cfm/ft² of casing area at a pressure of 5" wg.

3.4 PUMPS

- A. Furnish an extra set of mechanical seals for each pump and submit receipt acknowledging same.
- B. Provide base elbow supports for horizontal connections to base-mounted pumps.

- C. Install back pull-out type pumps with space and accommodations for back pull-out per the manufacturer's recommendations.
- D. Pump and motor alignment for each flexible-coupled pump shall be verified to be ± 0.002 " by the manufacturer after pump and piping have been installed and base has been grouted. Submit a written statement verifying completion and tolerance of alignment.

3.5 WATER TREATMENT SYSTEMS

- A. Systems shall include equipment, piping, fittings, installation, wiring and adjustments for manual operation as specified herein.
- B. Assist the building control system supplier with establishing remote monitoring of parameters as specified herein, including reasonable alarm values. Adjust the measurement range of analog outputs for conductivity and others based on expected operating conditions.

END OF SECTION 236000

SECTION 236500 – SPECIAL EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other HVAC systems are specified in other Sections of Division 23.
- B. This Section covers special HVAC equipment.
- C. Automatic temperature controls are specified in Section 238000, Automatic Temperature Controls.
- D. Testing, adjusting and balancing is specified in Section 230095, Testing, Adjusting and Balancing.
- E. This Section includes responsibilities and obligations in support of the performance verification specified in Section 230090, HVAC Performance Verification, and commissioning specified in Section _____.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. North Carolina State Electrical Code-2017.
 - 2. North Carolina State Energy Conservation Code-2018.
 - 3. North Carolina State Mechanical Code-2018.
- B. Pressure/temperature ratings of components and accessories shall meet or exceed design conditions for the system in which they are installed. Refer to Section 231000, Piping, Valves and Accessories, and requirements specified herein.

PART 2 - PRODUCTS

2.1 ENERGY RECOVERY UNITS

- A. Complete factory fabricated, custom-built, weatherproof, total air handling/energy recovery system with supply fans, exhaust fans, bearings, motors, drives, drive guards, variable frequency drives, cooling coils, heating coils, dampers, energy recovery wheels, filters, filter pressure gauges, and vibration isolation housed in a finished solid double-wall casing with thermal insulation and drain pan. Functional components shall be accessible for inspection and maintenance through hinged, solid double-wall access doors in each section.
- B. Units shall be run tested after assembly to ensure proper operation and a certified run test report shall be furnished. Units shall be factory leak tested by raising the static pressure to the operating static pressure and measuring the air leakage through a calibrated orifice plate. Maximum allowable leakage shall be no more than 1% of the supply fan cfm for the unit. Units shall be delivered to suit construction and handling requirements.
- C. Casings: panels shall be 2" thick with 20 gauge galvanized exterior sheeting and 22 gauge solid inner liner designed for positive 10" wg operating pressure. Fill material shall be 2" thick, 3 pcf mineral wool insulation with no uninsulated voids. Inner surfaces shall be smooth and accessible for cleaning. Provide hinged, double-wall access doors in service plenums and at locations indicated on the Drawings with minimum 60" height. Vaporproof service lights shall be provided in each casing section and wired to a switch inside the access door along with a 120 V AC convenience outlet. Provide sleeves through casing floor for piping, wiring and controls. Floor construction shall include structural reinforcement to support

internal equipment plus two 250 lb maintenance workers in each plenum. Provide weatherproof intake and exhaust sections including hoods or louvers. Hardware, fasteners and miscellaneous materials shall be corrosion-resistant. Assembled unit or each section of sectional units shall be provided with lifting lugs.

- D. Drain pans: constructed of type 304 stainless steel, sloped to provide positive self-drainage, with drain opening easily accessible for cleaning. Units with stacked cooling coils shall include a secondary drain pan under each coil with drain piping to main pan. Drain pans shall extend upstream and downstream as necessary to prevent wetting of service plenums or carryover of moisture droplets at 450 fpm cooling coil face velocity. Provide auxiliary drain pans or flashing to prevent wetting of unit floor from condensation on cooling coil return bends, piping or other cold surfaces within the unit.
- E. Supply and exhaust fans: centrifugal, plug type, designed without a scroll type housing, tested in accordance with ASHRAE 51/AMCA 210-2016. Fan wheels shall have continuously welded, die-formed airfoil blades with nonoverloading characteristics. Complete fan assemblies shall be statically and dynamically balanced.
- F. Bearings: pillow block or flange type with L_{10} life of 200000 hours at the peak operating condition.
- G. Motors and motor starters: as specified in Section 230010, HVAC General.
- H. Drives: V-belt type, as specified in Section 237000, Air Distribution.
- I. Variable frequency drives: as specified in Section 230010, HVAC General.
- J. Control dampers: provide dampers, as specified in Section 237000, Air Distribution, at intake and exhaust to control airflow.
 - 1. Control damper actuators: as specified in Section 238000, Automatic Temperature Controls.
 - 2. Other control system components: provide and install control devices located within the casings, as described in Section 238000, Automatic Temperature Controls. Coordinate type and characteristics of devices with the controls subcontractor.
- K. Energy recovery wheels: as specified in Paragraph 2.05, Energy Recovery Wheels.
- L. Filters: pleated type, as specified in Section 237000, Air Distribution.
- M. Filter pressure gauges: provide filter pressure gauges, as specified in Section 237000, Air Distribution. Gauges shall be surface-mounted on unit with high and low pressure connection, according to manufacturer's recommendations. Provide hood for gauges exposed to weather.
- N. Internal vibration isolation: internal vibration isolators shall be provided for supply and exhaust fan assemblies mounted on a common steel vibration base. Fans shall have a flexible connection to the casing. Internal vibration isolators shall be as specified in Section 230010, HVAC General, with minimum static deflection of 1.5".
- O. Electric control wiring: termination panels with terminal strips on exterior of casing, with wiring to each sensor and control component located within the unit. Wiring shall be in accordance with Section 238000, Automatic Temperature Controls.
- P. Main electric power wiring (fan motors): 480 V, 3-phase, 60 Hz wiring for main unit power serving fan motors shall be factory wired to a single connection point at a disconnect switch mounted on the unit exterior, for incoming 480 V, 3-phase, 60 Hz power source. Wiring shall be in accordance with Division 26.
- Q. Auxiliary electric power wiring: 120 V, 1-phase, 60 Hz wiring for auxiliary unit power serving lights and convenience outlets shall be factory wired to a single connection point at a disconnect switch mounted on

the unit exterior, for incoming 120 V, 1-phase, 60 Hz power source. Wiring shall be in accordance with Division 26.

- R. Manufacturer: Annexair, Daikin, Johnson Controls/York Solution, or Trane, Buffalo, Environmental Air Systems, or Semco

2.2 ENERGY RECOVERY WHEELS

- A. Energy recovery wheels: rotor media shall be made of coated, corrosion resistant aluminum. Surfaces shall be coated with a nonmigrating absorbent specifically designed for the selective transfer of water vapor. Provide an independent cross contamination test per ASHRAE 84-2013, proving the internal pore diameter of the desiccant does not exceed 4.0 angstroms or other means to limit carryover ratio to a maximum of 0.2%. The rotor media shall recover both sensible and latent energy with the same level of efficiency. Performance shall be clearly documented through a certification program conducted in accordance with AHRI 1060-2018 and ASHRAE 84-2013. The certification shall be conducted by a qualified independent organization. The media shall be cleanable with low temperature steam, hot water or light detergent, without degrading the latent recovery. Dry particles up to 800 microns shall freely pass through the media.
1. Purge sectors: the unit shall be provided with a factory set, field-adjustable purge sector (for non-contact seals) designed to limit cross contamination to less than 0.2% of that of the exhaust airstream concentration for wheels in outside air/exhaust air applications.
 2. Rotor seals: the rotor shall be supplied with labyrinth seals for nonpolished wheel surfaces rotating at higher than 20 rpm, which are at no time to make contact with any rotating surface of the exchanger rotor. Multipass seals shall utilize four labyrinth stages. For rotors with machine polished surfaces with a rotation of 20 rpm or less, provide a full contact seal. Contact seals shall be fabricated of abrasion resistant heavy weight polyethylene designed for the life of the wheel.
 3. Rotor support systems: the rotor media shall be provided in a segmented fashion to allow for field erection or replacement of one section at a time without requiring side access for wheel sizes larger than 96". The media shall be held by a structural spoke system made of extruded aluminum.
 4. Rotor housings: the rotor housing shall be a structural frame which limits the deflection of the rotor due to air pressure differential to less than 0.03125". The housing shall be made of galvanized steel. Rotors shall be supported by 2 rolling element bearings either permanently lubricated or, if regreaseable, designed to be maintained or replaced without the removal of the rotor from its casing or the media from its spoke system.
 5. Drive systems: the rotor shall be driven by a self-adjusting belt system. Motors shall be utilized for both constant and variable speed applications.
- B. Manufacturer: AnnexairDaikin, Johnson Controls/York Solution, or Trane, Buffalo, Environmental Air Systems

PART 3 - EXECUTION

END OF SECTION 236500

SECTION 237000 - AIR DISTRIBUTION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other HVAC systems are specified in other Sections of Division 23.
- B. This Section covers air distribution systems and equipment.
- C. Motorized dampers not furnished with equipment shall be provided under Section 238000, Automatic Temperature Controls.
- D. Testing, adjusting and balancing is specified in Section 230095, Testing, Adjusting and Balancing.
- E. This Section includes responsibilities and obligations in support of the performance verification specified in Section 230090, HVAC Performance Verification, and commissioning specified in Section_____.

1.2 QUALITY ASSURANCE

- A. Air conditioning systems shall conform to the following:
 - 1. North Carolina State Energy Conservation Code-2018.
 - 2. North Carolina State Mechanical Code-2018.
 - 3. SMACNA IAQ Guidelines for Occupied Buildings Under Construction-2007.

1.3 DEFINITIONS

- A. Sizes for lined ductwork indicated on the Drawings are sheet metal sizes.
- B. Ductwork shall have the following static pressure classifications, unless otherwise specified herein:
 - 1. From variable volume air handling units to terminal units: 4 " wg.
 - 2. From terminal units to grilles, registers and diffusers: 2 " wg.
 - 3. On the inlet of return air and toilet exhaust fans: - 2 " wg.
 - 4. On the discharge of return air and toilet exhaust fans: 2 " wg.
 - 5. Field-fabricated plenums and casings on the suction side of air handling units and fans: -4" wg.
 - 6. Field-fabricated plenums and casings on the discharge side of air handling units and fans: 6" wg.
- C. The first 20' of rectangular supply and return ductwork outside the HVAC room shall be constructed of 16 gauge sheet metal with a 6" wg static pressure classification for ductwork and transverse joints. The test pressure for duct leakage testing specified in 230095, Testing, Adjusting and Balancing may be equal to that used for downstream ductwork.

PART 2 - PRODUCTS

2.1 SHEET METAL WORK - GENERAL

- A. Ductwork, except where otherwise specified herein, including factory-fabricated round and flat oval, and apparatus casings shall be constructed of galvanized steel in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.
- B. Residential clothes dryer exhaust duct and supports shall be minimum 30 gauge galvanized steel.

2.2 SHEET METAL WORK - ACCESSORIES

- A. Zinc-rich paint: Sherwin-Williams Zinc-Clad III HS 100 Primer, Carboline Co. Carbozinc 585, or ZRC Worldwide Zero VOC Water-Based Galvanizing Compound.
 - 1. Zinc-rich primers that are applied on site and used inside the building must not exceed a volatile organic compound (VOC) content limit of 100 g/L per California CARB 2019 Suggested Control Measure (SCM) for Architectural Coatings.
- B. Weld or mechanical grip pins: AGM, Duro-Dyne, or Erico.
- C. Duct sealants: liquid, mastic, gasket, or tape and activator type, asbestos-free, complying with NFPA 90A-2018 and UL 181-2013.
 - 1. Duct sealants applied on site shall not exceed a volatile organic compound content limit of 420 g/L per SCAQMD 1168, 2017. Additionally, duct sealants applied on-site and used inside the building must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.2-2017, using the applicable exposure scenario.
- D. Draw bands: nylon type, complying with UL 181-2013, Class 1, and NFPA 90A-2018.
- E. Lining adhesive: ASTM C916-2014.
 - 1. Adhesives applied on site shall not exceed volatile organic compound content limits identified in SCAQMD 1168, 2017. Additionally, adhesives applied on-site and used inside the building must be tested and determined compliant in accordance with California Department of Public Health (CDPH) Standard Method v1.2-2017, using the applicable exposure scenario.
- F. Instrument test ports: flanged base with screw cap and gasket, and flat mounting gasket for flat or round duct. Height shall accommodate duct insulation thickness.
 - 1. Manufacturer: Ventlok 699 series.

2.3 PLENUM LINING

- A. Nonfibrous:
 - 1. Plenum lining shall be 1" thick, 3 pcf density, uncoated, nonfibrous board meeting ASTM C1534-2019, Type II.
 - 2. Lining and accessories shall have a composite flame spread rating of not more than 25 and a smoke developed rating of not more than 50.
 - 3. Manufacturer: Armacell AP Coilflex Duct Liner.

2.4 DUCT LINING

A. Fibrous:

1. Duct lining shall be coated fiberglass meeting ASTM C1071-2019, Type I. Coating shall not support the growth of fungus or bacteria when tested in accordance with ASTM G21-2015.
2. Density: 1" thick – 1.5 pcf; 2" thick – 1.5 pcf.
3. Lining and accessories shall have a composite flame spread rating of not more than 25 and a smoke developed rating of not more than 50.
4. Manufacturer:
 - a. Rectangular: CertainTeed ToughGard R Duct Liner, Johns Manville Linacoustic RC, or Owens Corning QuietR Rotary Duct Liner.
 - b. Round: CertainTeed ToughGard Ultra Round Spiral, Johns Manville Spiracoustic Plus, or Owens Corning QuietZone Spiral Duct Liner.

2.5 ROUND AND FLAT OVAL DUCTWORK

- A. Round and flat oval ductwork (except runouts to diffusers), including fittings and access panels, shall be factory-fabricated by a manufacturer regularly engaged in the quality production of such ductwork.
- B. Fittings shall have continuous welds along joints, and ductwork shall be the spiral type.
- C. Divided flow fittings (tees, crosses, laterals) shall be manufactured as separate fittings, not as tap collars welded into spiral duct sections.
- D. Entrances into laterals (side outlets) shall be made smooth by machining, press forming or grinding, and shall be without flow restrictions, projections, weld build-ups or burrs.
- E. Where size equals or exceeds 6", 90° takeoffs shall be of the conical type.
- F. Except where otherwise indicated on the Drawings, joints shall be made with slip couplings and screws or companion flanges as recommended by the manufacturer. Submit details for joints for exposed ductwork for approval.
- G. Factory-fabricated access panels shall be provided immediately downstream of each fire damper and other locations as specified herein. For duct smaller than 8", a removable duct section shall be provided. For larger ducts, an access panel section with access cover held in place by positive duct pressure and spring clips shall be provided. The access cover shall be galvanized steel, and of the insulated panel type when installed in insulated duct. The access panel housing shall be of welded construction with a pressure seal gasket around the cover.
- H. Lined round duct shall be factory-fabricated, and shall be provided with 1" or 2" thick, as indicated on the Drawings, 3 pcf fiberglass lining and perforated galvanized sheet metal liner.
- I. Elbows shall be smooth radius with a centerline radius of 1.5 times the duct diameter.
- J. Openings in round ductwork for linear diffusers shall be factory-cut. Sheet metal collars for linear diffusers shall be factory-installed on the duct.
- K. Manufacturer: Eastern Sheet Metal, Hamlin Sheet Metal, McGill AirFlow, or Semco.

2.6 FLEXIBLE CONNECTIONS

- A. Coated glass fabric not less than 3" 6" active length.

- B. Connections shall comply with NFPA 90A-2018, NFPA 701-2019, and shall be asbestos-free. Connections to engine-generator set radiators shall be designed for continuous use at 275°F. Connections exposed to weather shall also be sunlight and ozone resistant.
- C. Manufacturer: Duro-Dyne, or Ventfabrics.

2.7 ACCESS PANELS

- A. Tight fitting, hinged, except removable where necessitated by space conditions, double-wall insulated type, manufactured in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.
- B. Manufacturer: Air Balance, Krueger, Louvers & Dampers, Nailor, National Controlled Air, Phillips-Aire, Ruskin, or Ventlok.

2.8 ACCESS DOORS

- A. Tight fitting, hinged, double-wall insulated type, 24" x 60" clear inside opening.
 - 1. Manufacturer: Air Balance, Louvers & Dampers, National Controlled Air, or Ruskin.
- B. Handles, latches and hinges: cadmium-plated steel.
 - 1. Manufacturer: Duro-Dyne, Ventlok, or Young Regulator.

2.9 PRESSURE RELIEF DOORS

- A. Galvanized steel, 18" x 18", 12 gauge construction, insulated type with positive latch mechanism, perimeter door gasket, and automatic reset.
- B. Doors shall have pressure relief settings equal to 0.5" wg less than the static pressure rating of the duct.
- C. Manufacturer: Ruskin PRD18.

2.10 FLEXIBLE DUCTWORK

- A. Chlorinated polyethylene; aluminum foil, fiberglass, and aluminized polyester trilaminate; or coated woven fiberglass cloth, mechanically locked or permanently bonded to a noncorrosive metal helix. Factory-insulated with fiberglass with a protective vapor barrier jacket to achieve an ADC certified minimum R-value of 6.0°F·ft²·h/Btu at 75°F.
- B. Listed under UL 181-2013 as a Class 1 air duct, in compliance with NFPA 90A-2018, and rated for minimum 6" wg positive pressure and 0.75" wg negative pressure. Flexible ductwork upstream of terminal units shall be rated for a minimum of 10" wg positive pressure and 2" wg negative pressure.
- C. Manufacturer: Flexmaster, or Thermaflex.
- D. Chlorinated polyethylene core, permanently bonded to a noncorrosive metal helix. Factory-insulated with fiberglass with a protective vapor barrier jacket to achieve an ADC certified minimum R-value of 6.0°F·ft²·h/Btu at 75°F.
- E. Listed under UL 181-2013 as a Class 1 air duct, in compliance with NFPA 90A-2018, and rated for minimum 6" wg positive pressure and 0.5" wg negative pressure.

- F. Manufacturer: Flexmaster, or Thermaflex.

2.11 HANGERS AND SUPPORTS

- A. Duct hangers and supports shall be in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.

2.12 BACKDRAFT DAMPERS

- A. Heavy duty type with anti-leakage features, counterbalanced, parallel blade operation.
- B. Operating linkage: factory-assembled, steel construction.
- C. Counterbalance weights: adjustable, and mounted on the entering side. Not required on dampers located in ductwork on the discharge of fans.
- D. Frames: 16 gauge galvanized 3.5" channel with 0.875" double-thickness flanges, and corner bracing. Top and bottom stops and blade end seals shall be provided with galvanized angles spot welded to frame and sealed with sealer. Face of angles shall have replaceable, compressible polyurethane or neoprene seals.
- E. Blades: minimum 14 gauge extruded aluminum with extruded vinyl seals locked into blade edges. Maximum length 48".
- F. Pivot rods: plated steel or molded synthetic thermoplastic, 0.5" diameter or hex.
- G. Bearings: dusttight, ball type.
- H. Closed position guaranteed leakage rate: maximum 50 cfm/ft² at 1" wg differential static pressure based on a 48" damper width.
- I. Manufacturer: American Warming, Arrow, Dowco, Ruskin, or Shipman.

2.13 FIRE DAMPERS

- A. Factory-built curtain type, except where multiblade type is specified herein. Dampers shall be spring-operated with stainless steel constant tension springs, conforming to requirements of UL 555-2006 for dynamic operation, NFPA 90A-2018, and UL listed.
- B. Rating: 1.5 hours.
- C. Provide factory-built sleeves of design and length to permit mounting within the opening.
- D. Dampers in round ductwork shall be Type C.
- E. Dampers in rectangular ductwork with minimum dimension 30" and larger shall be the multiblade type with airfoil shaped blades.
- F. Dampers in rectangular ductwork with minimum dimension less than 30" shall be as follows:
 - 1. Dampers in return air openings or behind grilles or registers shall be Type A.
 - 2. For ductwork with a static pressure rating of 2" wg or less, dampers with a minimum dimension of 18" or smaller shall be Type B, and those with a minimum dimension of 19" and larger shall be Type A.

3. For ductwork with a static pressure rating greater than 2" wg, dampers shall be Type C.

- G. Fusible links shall have a temperature rating approximately 50°F above the maximum temperature that would normally be encountered with the system in operation or shutdown, but not less than 165°F.
- H. Manufacturer: Greenheck, Leader, Nailor, National Controlled Air, Phillips-Aire, Prefco, Ruskin, or Safe-Air.

2.14 SMOKE DAMPERS

- A. Factory-fabricated type, complying with UL 555S-2014 at 250°F and a minimum test pressure differential of 4" wg.
 - 1. Dampers in ductwork with a 2" wg and greater static pressure classification: airfoil blade design, Leakage Classification II, maximum rated airflow rate of at least 3000 fpm.
 - 2. Dampers in ductwork with a 1" wg and less static pressure classification, and in openings: Leakage Classification II, maximum rated airflow rate of at least 2000 fpm.
- B. Damper operators shall be factory-installed, power open, spring closed, 24 V AC, and shall be rated for a minimum of 250°F. Damper closure rate shall be 15 seconds minimum and 30 seconds maximum.
- C. Dampers in round ductwork up to 18" in diameter shall be the single-blade type. Dampers in round ductwork larger than 18" diameter shall be the multiblade type with connector sleeves. Minimum connector sleeve size shall be 2" larger in each dimension than the duct connection.
- D. Dampers in rectangular ductwork and in openings shall be multiblade type. Provide connector sleeves.
- E. Manufacturer: Air Balance, Greenheck, Leader, Nailor, National Controlled Air, Prefco, Ruskin, or Safe-Air.

2.15 COMBINATION FIRE/SMOKE DAMPERS

- A. Factory-fabricated type, complying with UL 555-2006 and UL 555S-2014 at 250°F and a minimum test pressure differential of 4" wg.
 - 1. 1.5 hour rating, with UL fire and leakage classification markings.
 - 2. Dampers in ductwork with a 2" wg and greater static pressure classification: airfoil blade design, Leakage Classification II, maximum rated airflow rate of at least 3000 fpm.
 - 3. Dampers in ductwork with a 1" wg and less static pressure classification, and in openings: Leakage Classification II, maximum rated airflow rate of at least 2000 fpm.
- B. Dampers shall have a 212°F thermal device which will close and lock the damper in the closed position. Damper operators shall be factory installed, power open, spring closed, 24 V AC, and shall be rated for 250°F. Damper closure rate, on smoke mode, shall be 15 seconds minimum and 30 seconds maximum.
- C. Dampers in round ductwork up to 18" in diameter shall be the single-blade type. Dampers in round ductwork larger than 18" diameter shall be the multiblade type with connector sleeves. Minimum connector sleeve size shall be 2" larger in each dimension than the duct connection.
- D. Dampers in rectangular ductwork and in openings shall be multiblade type. Provide connector sleeves.
- E. Manufacturer: Air Balance, Greenheck, Leader, Nailor, National Controlled Air, Prefco, Ruskin, or Safe-Air.

2.16 MANUAL DAMPERS

- A. Single blade up to 8" high, opposed multiblade over 8" high; minimum 80% free area based on damper frame outside dimensions.
- B. Blades: minimum 16 gauge galvanized steel, or airfoil shape extruded aluminum.
 - 1. Pivot rods: steel, minimum 0.5" diameter or hex, with one rod extended 6" to permit operation of damper from outside the duct.
 - 2. Maximum length 42"; maximum width 8".
 - 3. For low leakage applications: at points of contact provide interlocking or overlapping edges, compressible neoprene or extruded vinyl blade seals, and compressible metal side seals, designed for temperature of -40°F to 180°F at leakage rate specified herein.
- C. Frames: galvanized steel bar minimum 2" wide x 12 gauge for dampers 10" high or less, and 3.5" x 0.875", 16 gauge galvanized roll-formed channel with double-thickness edges or 5" x 1" x 0.125" extruded aluminum channel for 11" high and larger.
 - 1. Corner bracing.
 - 2. Full size of duct or opening in which installed.
- D. Bearings: bronze sleeve, steel ball type, or Cylcoloy 800.
 - 1. Vertically-mounted: thrust bearings.
 - 2. Maximum spacing: 42".
- E. Quadrants: cadmium-plated steel, with damper locking device, and damper position indicator.
 - 1. Manufacturer: Arrow Q-38, Duro-Dyne KL-7R, or Ventlok 560.
- F. Finish on steel parts: galvanized.
- G. Operating linkage: factory-assembled, concealed in frame out of airstream, steel construction.
- H. For low leakage applications: leakage when closed shall be less than 4 cfm/ft² at 1" wg differential static pressure based on a 48" damper width.

2.17 CONTROL DAMPERS

- A. As specified in Section 238000, Automatic Temperature Controls.

2.18 GRILLES, REGISTERS AND DIFFUSERS

- A. General:
 - 1. Selection of grilles, registers and diffusers shall be based on air introduced at a 20°F temperature differential.
 - 2. Grilles and registers with borders shall have felt or rubber gaskets cemented to the back face and holding screws not over 18" on center around the perimeter.
 - 3. Wall-mounted grilles and registers located less than 7' above finished floor shall be heavy duty, impact-resistant type.
 - 4. Diffusers in lay-in ceilings shall lay in a nominal 24" x 24" grid opening and shall be furnished without exposed flanges.
 - 5. Register dampers: gang-operated, opposed-blade type, operated through the face of the register. Operating mechanism shall not project through the register face.
 - 6. Extractors: adjustable through the face of the grille or register.

7. Diffusers shall be complete with straightening vanes, and opposed or rotating blade volume control dampers. Straightening vanes are not required where diffusers are attached to round flexible ductwork. Volume control dampers are not required where single diffusers are served by branch ducts with dampers at take-offs.
8. Internal parts of diffusers shall be designed so they can be adjusted, removed, and assembled without special tools.
9. Diffusers shall have round necks or shall be provided with square-to-round collars where connected to round or flexible duct.
10. Finishes, unless otherwise specified herein:
 - a. Steel grilles and registers: white baked enamel.
 - b. Diffuser faces and frames: white baked enamel.
 - c. Diffusers interior: same as face and frame
 - d. T-bar slot diffusers: flat black.
11. Grilles, registers and diffusers shall be provided with frames, borders, and mounting attachments for installation in the actual wall, soffit, and ceiling construction in which installed.

B. Supply Devices:

1. Type S-CF - Square cone face diffuser type, 24" x 24" face, minimum of 3 stamped cones, horizontal/vertical pattern adjustment device, 1-piece construction.
2. Type S-SR - Sidewall supply register, double-deflection type with vertical front blades, horizontal rear blades, and opposed-blade volume damper.
3. Type S-LD - Linear diffuser, extruded aluminum type, with 3 0.5" 0.75" 1" wide slots with integral volume control and pattern adjustment and concealed mounting frame. Finish in baked enamel with white face, and interior components visible after installation finished flat black.

<u>Type</u>	<u>Number of Slots</u>	<u>Slot Width</u>
S-LD-1	2	0.5"
S-LD-2	6	1"

C. Return and Exhaust Devices:

1. Type R-EG - Eggcrate grille, 0.5" x 0.5" x 0.5" fabricated aluminum eggcrate. Where indicated on the Drawings, provide hinged cores or separate hinged mounting frames.
2. Type R-SR - Sidewall register, single-deflection, 35° fixed position, 0.5" on center, horizontal blades with opposed-blade volume damper.

D. Manufacturer, unless otherwise noted: Anemostat, Carnes, Krueger, Metal*Aire, Nailor, E.H. Price, Titus, or Tuttle & Bailey.

2.19 FANS - GENERAL

A. Rated in accordance with AMCA 211-2013 (R2018), AMCA 300-2014, and ASHRAE 51/AMCA 210-2016.

B. Drives:

1. V-belt type, sized for 140% of motor size. Belt drive fans used in smoke control systems shall have 1.5 times the number of belts required for the design duty, minimum 2 belts.
2. Construction: cast iron. Sheaves for drives 5 hp and larger shall have bushed bores.
3. Motor sheaves: fixed pitch once final balancing and commissioning is completed.
4. Companion sheaves: to maintain belts parallel.

5. Temporary motor sheaves for final balancing and commissioning: variable pitch for motors through 25 hp or fan speeds less than 1000 rpm; fixed pitch for motors over 25 hp or fan speeds over 1000 rpm, and for variable frequency drives.
- C. Motors; and variable frequency drives: as specified in Section 230010, HVAC General, unless otherwise specified herein.
- D. Control circuit transformers: for actuators on fans with 3-phase motors.
- E. Wheels and shafts: factory-balanced, both statically and dynamically as an assembly. Fans with variable frequency drives shall be dynamically balanced throughout the complete speed range.
- F. Bearings: ball, roller, or taper roller type. Bearings for cabinet fans, centrifugal inline duct fans, propeller fans, and power roof ventilators shall have an L₁₀ life of 50000 hours. Other bearings shall have an L₁₀ life of 100000 hours. Bearing life shall be calculated based on the peak operating condition indicated on the Drawings.

2.20 FILTERS

A. General:

1. MERV ratings shall be based on ASHRAE 52.2-2017.
2. Filters shall be UL 900-2015 Class 1.

B. Pleated Filters:

1. 2" thick pleated, disposable type. Each filter shall consist of media and enclosing frame. Media shall be self-supported or shall contain a support grid. Initial resistance shall not exceed 0.25" wg based on 500 fpm
2. Filter media shall be reinforced nonwoven cotton fabric type with a minimum MERV rating of 6.
3. The effective filter media shall be not less than 7 ft² of media per ft² of filter face area.
4. Self-supported media shall be capable of maintaining its shape and pleat spacing during normal use. Filters with self-supported media shall maintain functionality if filter frame is damaged.
5. The media support shall be a welded grid with an effective open area of not less than 96%. The welded wire grid shall be bonded to the filter media to eliminate the possibility of media oscillation and media pullaway. The media support grid shall be formed in such a manner that pleats are rounded, allowing total use of filter media.
6. The enclosing frame shall be constructed of rigid, heavy duty, chipboard with diagonal or longitudinal support members bonded to the air entering and air exit side of each pleat to ensure pleat stability. The inside periphery of the enclosing frame shall be bonded to the filter pack.
7. Housings: factory-fabricated of galvanized steel, double-wall insulated type, with tracks for filters, and side access door with seal. Filter enclosing frames and housing shall form an airtight seal.
8. Frame retainers: designed to fit together to form a filter bank with airtight joints. Retainers shall be galvanized steel with gaskets and fasteners.
9. Manufacturer: Airguard DP, American Air Filter Am-Air 300X PerfectPleat, or Farr 30-30.

C. Bag Filters:

1. Supported type, nominal depth 24". Media shall have a minimum MERV rating of 13. Capacity shall be based on 500 fpm.
2. Filter media shall be supported with a corrosion resistant steel wire basket, and shall be synthetic. micro-glass fiber.
3. Housings: factory-fabricated of galvanized steel, double-wall insulated type, with tracks for filters, and side access door with seal. Filter enclosing frames and housing shall form an airtight seal.
4. Frame retainers: designed to fit together to form a filter bank with airtight joints. Retainers shall be galvanized steel with gaskets and fasteners.

5. Manufacturer: Airguard Venti-Pak, American Air Filter DriPak, Pureklean, or Farr Hi-Flo.
6. Manufacturer: American Air Filter Dripak 2000, or Farr HP.

2.21 FILTER PRESSURE GAUGES

- A. Differential pressure gauges shall have a range 0" wg to 1" wg. , Gauges shall have 4" dial face, pointer zero adjustment, transmitter with two wire 4-20 mA output and zero and span adjustments for remote monitoring, 1/8 female NPT connections, and mounting accessories.
 1. Manufacturer: Dwyer Magnehelic 605.

2.22 ROOF CURBS AND EQUIPMENT SUPPORT RAILS

- A. Prefabricated type, 16-gauge aluminum with welded joints, raised cant to match roof deck insulation, and 1.5", 3 pcf fiberglass insulation. Top surfaces shall be level, with construction to fit roof pitch. Minimum height, at the lowest point, shall be 8".
- B. Manufacturer: AES Industries, Pate, Penn, Roof Curb Products, Roof Products & Systems, or Thy Curb.

2.23 SIDE TAKEOFF FITTINGS

- A. Minimum 26 gauge galvanized steel, designed for minimum pressure drop by an expansion from a rectangular connection to a round duct. The fitting shall include a 1" wide mounting flange with die formed corner clips, prepunched mounting holes, and an adhesive-coated flange gasket. The outlet collar shall be crimped and incorporate a bead.
- B. Manufacturer: Crown, or Flexmaster.

2.24 SMOKE DETECTORS

- A. As specified in Section 238000, Automatic Temperature Controls.

PART 3 - EXECUTION

3.1 SHEET METAL WORK - GENERAL

- A. Unless otherwise specified herein or indicated on the Drawings, construct and install sheet metal work in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.
- B. Workmanship, methods of assembly, joint and seam construction, and sealants for sheet metal work shall be designed for the duct leakage classifications specified in Section 230095, Testing, Adjusting and Balancing.
- C. Changes in shape, dimension, or direction shall be made with a maximum transition, offset, or combination thereof of 1 to 7.
- D. Except where indicated otherwise on the Drawings, use metal hat sections or standoff brackets in lined ductwork to install dampers, turning vanes or coils. Hat sections or standoff brackets shall be the same height as the lining thickness.
- E. Openings in plenum casings for access doors shall be 9" above the floor. Hinge doors to close with plenum pressure.

- F. Separate galvanized sheet metal from aluminum or copper with lead or felt gaskets.
- G. Provide supplemental stiffening and supports to ducts and apparatus casings to prevent drumming, sagging and to provide a structurally sound assembly.
- H. Ductwork and sheet metal seams, joints, penetrations, connections and attachments shall be sealed.
 - 1. Sealants shall be applied in accordance with the manufacturer's recommendations for each specific application.
 - 2. Ductwork failing the leakage tests specified in Section 230095, Testing, Adjusting and Balancing shall be repaired, reworked or rebuilt until satisfactory, before additional ductwork is installed and before ductwork is concealed.
- I. Entire air system installation shall be rigid, and free from rattles and air noises. Interior of ducts shall be smooth.
- J. Provide angle brackets inside ductwork on both sides to support slip-in electric heating coils in vertical ducts over 24" wide.
- K. Provide transitions between different size sections of air handling units.
- L. Install duct from shower exhaust grilles grading down to the exhaust grille, without traps or dips.
- M. Install uninsulated ductwork exposed in finished areas against the ceiling.
- N. Provide offsets, elbows, and transitions to coordinate with other work.
- O. Provide transitions to connect ductwork to equipment and coils.
- P. Elbows:
 - 1. Elbows in round and flat oval ductwork are specified hereinbefore.
 - 2. Radius elbows in rectangular and square ductwork shall have an inside radius equal to the width of the duct, except where space conditions prohibit, in which case a reduced inside radius with full heel radius is permitted. Where the space conditions require the inside radius to be less than 75% of the duct width, provide multiple splitter vanes inside the elbow.
 - 3. Square (mitered) elbows in rectangular and square ductwork shall contain single-thickness turning vanes and shall be limited to 90° turn applications.
 - a. Vanes shall be parallel to airflow.
 - b. Vanes exceeding the maximum unsupported length defined by SMACNA shall be divided into multiple sections with intermediate vane rails or shall be braced with tie rods spanning perpendicularly across the leading edges of the vanes. The tie rods shall be welded to the leading edge of each vane.
 - 4. Turns less than 90° in rectangular and square ductwork shall be made with radius type elbows. Mitered elbows are not permitted.
- Q. Seal wall and floor penetrations as specified in Section 230010, HVAC General.
- R. Internal surfaces of clothes dryer exhaust shall be free of obstructions. Sheet metal screws shall not be used for fastening. Elbows in square and rectangular ductwork shall be radius type without splitter vanes.
- S. Instrument test ports: provide where required for measurements.

3.2 AIR DISTRIBUTION SYSTEMS

- A. Provide a written construction indoor air quality (IAQ) management plan for use during demolition and construction. Maintain a detailed digital photograph log of the IAQ plan practices followed during construction.

3.3 PLENUM LINING

- A. Line AHU AND ERU connections with fibrous nonfibrous plenum lining.
- B. Install lining with coated side facing air stream. Adhere lining to inside of plenums with 100% coverage of adhesive. Coat exposed edges and joints with edge sealer. Attach lining and cover to sheet metal plenums with weld or mechanical grip pins 16" on center. Mechanical fasteners shall not compress the lining more than 0.125". Coat field cuts and minor surface damage with edge sealer after lining is installed. Adhere lining to masonry with insulation hangers set in adhesive 12" on center.
- C. Cover lining with 0.5" galvanized hardware cloth or galvanized expanded metal.

3.4 DUCT LINING

- A. Line 10' downstream of terminal boxes ductwork, as indicated on the Drawings, with duct fibrous lining.
- B. Do not install lining within 18" upstream or 30" downstream of electric heating coils
- C. Install lining, except where otherwise specified herein, with coated side facing air stream and in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005. Adhere lining to inside of duct with 100% coverage of adhesive. In addition, weld or mechanical grip pins shall be installed with spacing conforming to SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005, for velocities over 2500 fpm. Mechanical fasteners shall not compress the lining more than 0.125". Coat exposed edges and joints with edge sealer. Protect leading edges against flaking by 24 gauge galvanized metal protectors. Butt and seal edges of lining together to form a continuous thermal barrier. Coat field cuts and minor surface damage with edge sealer after lining is installed.

3.5 ROUND AND FLAT OVAL DUCTWORK

- A. Exposed ductwork shall be parallel to building surfaces and structural members, and shall have seams aligned at joints.
- B. Construct a mock-up of exposed ductwork showing typical joints, methods of support, linear diffusers, and fittings for approval by the Architect before fabrication of exposed ductwork.
- C. Joints shall be sealed with duct sealer. Duct sealer shall not be visible on the exterior of the ductwork. Sheet metal screws shall not be used for joints in dryer exhaust.

3.6 FLEXIBLE CONNECTIONS

- A. Joints and seams shall be sealed airtight.
- B. Provide at:
 - 1. Inlet and outlet of fans.
 - 2. Duct connections to air handling units, or on inlet and outlet of fan section only if fan section is separate.

3. Duct connections to engine-generator set radiators.
 - C. Not required at:
 1. Power roof ventilators.
 2. Air handling units with internally isolated fan, motor and drive.
 3. Fan-powered terminal units with internally isolated fan and drive.
 - D. Provide a braided copper bridge strap across flexible connections.
- 3.7 ACCESS PANELS AND ACCESS DOORS
- A. Provide access panels of sufficient size and quantity for access to fire dampers, smoke dampers, controls, air measuring stations, coils, duct smoke detectors, and where ductwork covers electrical boxes. Install in appropriate locations to allow cleaning, oiling, inspection, repair and maintenance.
 - B. Open each to verify that swing space is clear and access into duct or plenum is unobstructed.
- 3.8 PRESSURE RELIEF DOORS
- A. Install vertically with the latch mechanism at the top.
- 3.9 FLEXIBLE DUCTWORK
- A. Install flexible ductwork in a fully extended condition, free of sags and kinks, using the minimum length to make connection. Seal joints as recommended by manufacturer. Maximum length of flexible ducts to diffusers shall be 7'. Maximum length of flexible ducts to terminal units shall be 3'. Use round galvanized duct, same size as flexible duct, for longer runouts.
 - B. Flexible ductwork shall be fastened to spin-in fittings, collars and transitions by draw bands and duct tape.
 - C. For diffusers, size same diameter as diffuser neck to which it connects.
 - D. For terminal units, size as indicated on the terminal unit detail.
 - E. Where size of flexible duct is different than size of collar, make connection with a sheet metal transition.
- 3.10 HANGERS AND SUPPORTS
- A. Adjust hangers and supports so that loading is uniform.
 - B. Unless otherwise specified herein or indicated on the Drawings, duct hangers and supports shall be in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.
 - C. Support horizontal ductwork not more than 8' on center. Ductwork shall be directly suspended from or supported by the building structure.
 - D. Support ductwork associated with Air Handling Units directly from fire resistant rated structural elements of the building.
 - E. Support round ductwork with straps and hangers as recommended by the manufacturer and SMACNA.

- F. Hang horizontal range hood and grill hood exhaust duct with rods secured to the structure and attached to trapeze angles or clips welded to the duct.
- G. Support sound attenuators independently of the ductwork.
- H. Flat oval ductwork shall be reinforced and supported with trapeze hangers.
- I. Where ducts are suspended below ceilings, extend hangers through the ceiling and secure to the structure as specified herein.
- J. Support vertical ducts at each floor with a minimum of 2 supports attached to the duct and fastened to the floor or structure.

3.11 FIRE DAMPERS

- A. Install within the thickness of the rated construction.
- B. Verify accessibility of each fire damper through duct and building access panels, and operation of each fire damper by removing link and operating damper.

3.12 SMOKE DAMPERS

- A. Install in accordance with conditions of UL listing.
- B. Locate within 24" of the smoke barrier.
- C. Install so that blades, when open, are no more than 5° off-axis with airflow.
- D. Verify accessibility of each smoke damper through duct and building access panels, and operation of each smoke damper by removing operator and operating damper.

3.13 COMBINATION FIRE/SMOKE DAMPERS

- A. Install within the thickness of the rated construction.
- B. Install so that blades, when open, are no more than 5° off-axis with airflow.
- C. Verify accessibility of each combination fire/smoke damper through duct and building access panels, and operation of each combination fire/smoke damper by removing link and operator and operating damper.

3.14 MANUAL DAMPERS

- A. Install dampers in accordance with manufacturer's instructions to operate freely.
- B. Provide standoff brackets, sized to clear the insulation thickness, for quadrants installed on insulated ductwork.

3.15 CONTROL DAMPERS

- A. Install dampers in accordance with manufacturer's instructions to operate and to obtain leakage rates specified herein. Adjust the damper linkage such that the damper closes before the actuator is fully closed to assure tight closure of the damper.

- B. Blank-off and seal around dampers and between dampers and sleeves or frames to eliminate air bypass.

3.16 GRILLES, REGISTERS AND DIFFUSERS

- A. Wall return and relief grilles installed above eye level shall be installed with blades angled so the inside of the duct or the adjacent space will not be visible through the grilles.
- B. Lengths of linear diffusers indicated on the Drawings are nominal. Coordinate actual lengths required with field conditions and/or the Architectural Drawings.

3.17 FANS - GENERAL

- A. Install centrifugal fans with a minimum of 2.5 duct diameters of straight duct at the inlet.

3.18 FILTERS

- A. Install filters and media to be used while the building is under construction. Replace during construction as filters and media become loaded. Prior to final inspection, remove these filters and media and replace with new filters and media.
- B. Install temporary filter media to protect return air grilles, registers and openings of permanent air handling systems operated while the building is under construction. Media shall be installed to prevent leakage around and bypass of filters.
- C. Each bank of activated carbon filter units shall be fitted with a test element to be used for laboratory determination of the degree of saturation of the units. This operation shall be part of the manufacturer's replacement service.
 - 1. Filters shall not be installed in the bank until final inspection.

3.19 FILTER PRESSURE GAUGES

- A. Provide a differential pressure gauge, unless otherwise specified herein, across each bank of filters and/or filter housing.
- B. Gauges shall be located so as to be visible.

3.20 SIDE TAKEOFF FITTINGS

- A. Provide for takeoffs from rectangular ductwork to terminal units.
- B. Install 45° takeoff fittings to correspond with direction of airflow.
- C. Install concentric takeoff fittings where terminal units are connected to the supply duct loop.

3.21 SMOKE DETECTORS

- A. Duct-mounted smoke detectors shall be located as follows:
 - 1. Within 60" of its respective smoke damper with no outlets or inlets between the detectors and damper.
 - 2. Between the smoke damper and any duct opening or connection.

3. In a straight section of duct.
 4. To be accessible.
- B. Locate remote test and alarm stations near the detector served, and mount approximately 6" below the ceiling.

END OF SECTION 237000

SECTION 238000 – AUTOMATIC TEMPERATURE CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and HVAC systems are specified in other Sections of Division 23.
- B. This Section covers automatic temperature control systems and equipment.
- C. This Section includes responsibilities and obligations in support of the performance verification specified in Section 230090, HVAC Performance Verification, and commissioning specified in Section _____.
- D. The BCS includes the network of interoperable, stand-alone digital controllers communicating via network devices.

1.2 RELATED WORK

- A. The installation of motor starters that are not factory-installed, thermal overload switches, and power wiring to motors, starters, thermal overload switches, electric heating coils, and contactors, is specified in another Division. This Section includes the furnishing and installation of controls and wiring for automatic controls, electric damper and valve actuators and motors, terminal unit controllers, interlocks, starting circuits, and 120 V and low voltage power wiring to power consuming control devices.
- B. Area smoke detectors are provided, installed and wired under Division 28. Duct smoke detectors shall be installed under Division 23, but furnished and wired into the fire alarm system under Division 28. This Section includes wiring fire alarm signal relays, provided and installed under another Division, to the automatic temperature control systems.
- C. Flow measuring systems, except flow meters for system control, are specified in Section 231000, Piping, Valves and Accessories.
- D. The monitoring and data logging capabilities of the BCS shall be available for use in the commissioning process.

1.3 QUALITY ASSURANCE

- A. Within 30 days after notice to proceed, submit resumes for the project manager, application engineer and field supervisor assigned to the Project. The Owner and Engineer reserve the right to exclude proposed staff not having the experience deemed sufficient for the Project. The proposed staff shall have the following minimum experience levels:
 - 1. Project manager: 5 years experience, and two projects of similar size and type.
 - 2. Application engineer: 7 years experience, and be manufacturer-certified for the system being provided, and Niagara 4 certified.
 - 3. Field supervisor: 5 years experience, and be manufacturer-certified for the system being provided, and Niagara 4 certified.
- B. Conform to the following:
 - 1. NFPA 70-2020.
 - 2. North Carolina State Electrical Code-2017.
- C. Installation shall be by technicians trained by the control manufacturer.

- D. Controllers and software shall have a current BTL listing.
- E. Controllers and network devices associated with the smoke control systems shall be UL 864-2014 (R2018)/UUKL listed.

1.4 SOFTWARE LICENSING

- A. The BCS software license shall grant use of all programs and application software to the Owner as defined by the manufacturer's license agreement.
- B. The Owner shall be the named license holder of all BCS software associated with the Project. In addition, the Owner shall receive ownership of all Project specific configuration documentation, data files, and application-level software developed for the Project. This shall include all custom, Project specific software code and documentation for all configuration and programming that is generated for this Project and configured for use with the BCS, NACs, and related communications devices. Required usernames and passwords for access to any component or software program shall be provided to the Owner.
- C. The NACs, central server, and other Niagara framework components shall have an unrestricted interoperability license with a Niagara Compatibility Statement (NiCS) following the Tridium Open NiCS Specification and shall have a value of "All" for "Station Compatibility In", "Station Compatibility Out", "Tool Compatibility In" and "Tool Compatibility Out". Note that this will result in the following entries in the license.dat file:

```
"accept.station.in=*"
"accept.station.out=*"
"accept.wb.in=*"
"accept.wb.out=*"

```

1.5 SUBMITTALS

- A. Submit a single comprehensive submittal package including the following items. At the Contractor's option, control valves and control dampers may be submitted in a separate submittal in advance of the other items to maintain project schedule.
 - 1. Control valve data: including manufacturer's product data and schedule indicating body type, size, flow rate, pressure drop, actuators and motors, end switches, normal (failure) position, and maximum differential pressure at which valve is capable of full closure for each valve.
 - 2. Control damper data: including manufacturer's product data and schedule indicating damper type, size, flow rate, pressure drop, leakage rate, actuators and motors, actuator torque, end switches and normal (failure) position for each damper.
 - 3. Pressure sensor data: including manufacturer's product data and schedule indicating the sensor type, range, and accuracy, and denoted with a discrete tag for each sensor and a description of the associated system and mounting location.
 - 4. BCS data: including control manufacturer's data sheets on BCS controllers, NACs, workstations, sensors, meters, relays, actuators, motors, terminal unit controllers, protection devices, and other devices specified herein. Include data on software.
 - 5. Network data: including switches, converters, routers, broadcast management devices and cabling, as necessary.
 - 6. Graphics: include illustrations of proposed graphics displays, including a flowchart or site map indicating system navigation links.
 - 7. Diagrams: separate field wiring diagrams for each system, including motor starting and interlock wiring, ladder diagrams, control wiring, interior electrical circuits of control instruments with terminal and control device designations, actuators and motors, colors of wires, locations of instruments and remote elements, interfaces with communications equipment provided with

- equipment specified in other Sections, and normal position of relays. Each diagram shall have terminals labeled as they will be marked on the installed equipment.
8. System architecture: provide a drawing of the proposed system architecture showing configuration and locations for BCS controllers, terminal unit controllers, system servers, control wiring for each device, and hardware and wiring for connections. Indicate the spare capacity and BACnet instance number or network address for each device. Include networking hardware such as switches, converters, routers, and broadcast management devices, and indicate IP addresses. Provide diagrams of the proposed control power infrastructure, including the designation of the electrical panelboards that will be utilized to provide control power, the quantity, configuration, size, and location of controls system transformers, and the distribution wiring to power consuming control devices. Provide floor plans locating equipment coordinated with the work of other trades.
 9. Uninterruptible power supplies: provide wiring diagrams and sizing calculations for uninterruptible power supplies.
 10. Sequences of operation: complete detailed sequences of operation, including a narrative of the system operation and interactions and interlocks with other systems, notations indicating whether interlock or interaction is accomplished through software or hard wired connections, detailed delineation of control between packaged controls and the BCS, and sequences of operation for packaged controlled equipment that interfaces with the BCS.
 11. BCS system server data: manufacturer's data sheets on the server equipment including computers, monitors, printers, UPS, communications equipment, other devices specified herein.
 12. System implementation requirements: network, workstation, and Web browser requirements for BCS functionality on the Owner's systems. Indicate operating system and java requirements for compatibility.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Johnson Controls Metasys, American Auto-Matrix
- B. The manufacturers' product lines specified above shall be a complete system of NACs, BCS controllers, and terminal unit controllers used consistently throughout the Project. BCS and terminal unit controllers shall be programmable from the NACs and server using a Niagara 4 browser platform with embedded workbench tools or separate web-accessible tools on the server. Programming tools and license shall be open and provided to the Owner.

2.2 SYSTEM ARCHITECTURE

- A. Provide a complete peer-to-peer networked, stand-alone, distributed BCS to perform the controls functions and monitor the points specified herein and on the Drawings. The BCS shall be engineered and equipment selected by the manufacturer as required to meet the performance specified herein. The BCS shall be comprised of a network of interoperable, stand-alone digital controllers communicating via the BACnet communication protocols with one or multiple NACs. Lower level networks utilizing BACnet over MS/TP shall only serve terminal units. The FMCS shall interface with the electric and electronic systems to provide control outputs and monitoring inputs to the FMCS as specified herein and as indicated on the Drawings. Complete electric control systems shall be provided to perform sequences not indicated to be performed by the FMCS. The BCSs shall interface with the electric and electronic systems to provide control outputs and monitoring inputs to the BCSs as specified herein and as indicated on the Drawings. Provide communications media, connectors, repeaters, bridges, switches, and routers necessary to provide a fully functional BCS network. Complete electric control systems shall be provided to perform sequences not indicated to be performed by the BCSs. The location and quantity of BCS controllers shall be as determined by the BCS manufacturer except that, as a minimum, a separate stand-alone controller shall be provided for each refrigeration plant, heating plant, air handling unit over 3 hp, and as indicated on the Drawings. Sensors and control points for each system shall be connected to its associated stand-alone controller. Each

BCS controller shall be designed to allow for the future addition of at least 20% of the number of connected input/output points; it is acceptable to achieve the 20% spare capacity with 10% spare on the BCS controller with capability of adding input/output expansion modules with an additional 10%. BCS controller spare capacity shall apply to both analog and digital control points. The BCS, including the system servers, the network components, and network area controllers (NACs), shall be designed to allow for the future addition of at least 100% of the number of control objects connected to the components or systems. An alarm condition shall be reported to the appropriate operator device no more than 10 seconds following the occurrence of that condition. Sensor and control values displayed to the operator in graphics displays shall be dynamically updated within 10 seconds of significant change of value, with a typical response time of 1 second or less.

- B. Lower level networks serving terminal units, such as BACnet over MS/TP, shall be connected to the associated air handling unit controller. When multiple lower level networks are required for a single air handling unit, those networks shall be divided in an orderly method, such as by floor or wing. Remote sensors shall be wired to the controller associated with that sensor, unless specified otherwise.
- C. The system shall have the capability to integrate ASHRAE 135-2016, BACnet, LonMark, MODBUS, OPC, and other open and proprietary communication protocols into one open, interoperable system.
- D. The following functions shall be performed at the server or NAC:
 - 1. Calendar functions.
 - 2. Scheduling.
 - 3. Trending.
 - 4. Alarm monitoring and routing.
 - a. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including, but not limited to:
 - 1) In alarm.
 - 2) Return to normal.
 - 3) Fault condition.
 - b. Provide for the creation of a minimum of 8 alarm classes.
 - c. Provide time scheduled routing of alarms by class, object, group, or node.
 - d. Provide alarm generation for equipment runtimes and other event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
 - e. Controller and network failures shall be treated as alarms and annunciated.
 - f. Alarms shall be annunciated in any of the following manners as defined by the user:
 - 1) Screen message text.
 - 2) E-mail of the complete alarm message to multiple recipients via the Owner's e-mail service. Provide the ability to route and e-mail alarms based on:
 - a) Day of week.
 - b) Time of day.
 - c) Recipient.
 - d) Pagers.
 - e) Graphics showing flashing items in alarm.
 - f) Printed message, routed directly to a dedicated alarm printer.
 - g. The following, at a minimum, shall be recorded:
 - 1) Time and date.
 - 2) Location (building, floor, zone, office number, etc.).
 - 3) Equipment (air handling unit number, access way, etc.).
 - 4) Acknowledge time, date, and user who issued acknowledgement.
 - 5) Number of occurrences since last acknowledgement.

- h. Alarm actions may be initiated by user-defined programmable objects created for that purpose.
 - i. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms.
 - j. A log of all alarms shall be maintained by the NAC and/or a server (if configured in the system) and shall be available for review by the user.
 - k. Provide a "query" feature to allow review of specific alarms by user defined parameters.
- 5. Time synchronization.
- 6. Web browser access via an intranet and the internet, supporting a minimum of 32 simultaneous users.
- 7. The following additional logs shall be included and made available to the user:
 - a. System alerts, such as controller and network failures.
 - b. Errors, such as invalid property changes or commands.

2.3 CONTROLLERS

A. Network Area Controllers (NACs):

- 1. The Contractor shall supply one or more NACs. The quantity and location of NACs is dependent on the type and quantity of control points and devices, and the functionality specified herein, and shall be determined by the Contractor.
- 2. NACs shall provide the interface between the building's communications system and the BCS control devices, and provide global supervisory control functions over the control devices connected to each NAC. It shall be capable of executing application control programs. It shall perform the following functions:
 - a. Integration of LonWorks and BACnet controller data.
 - b. Network management functions for control devices.
- 3. NACs shall have the following hardware features as a minimum:
 - a. Two ethernet ports - 10/100 Mbps.
 - b. One LonWorks interface port - 78KB FTT-10A.
 - c. Two RS-485 ports.
 - d. Battery back-up and flash memory for long term data backup, with minimum 1 gigabyte storage capacity.
- 4. Local UPS battery backup shall be installed within NAC Enclosure.
- 5. NACs shall be capable of operating under a temperature range between 32°F to 122°F and a humidity range between 5% to 95% RH, non-condensing, and of being stored under a temperature range between 0°F and 158°F.
- 6. NACs shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the NACs shall be an ODBC-compliant database or shall provide an ODBC data access mechanism to read and write data stored within it.
- 7. Alarm Notifications and Actions:
 - a. NACs shall provide alarm recognition, storage, routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
 - b. NACs shall be able to route any alarm condition to any defined user location whether connected to a local network, or remote via dial-up telephone connection or wide-area network.

B. BCS controllers: field programmable, microprocessor-based type incorporating direct digital control and energy management functions. Each BCS controller shall perform its assigned control and energy management functions as a stand-alone unit and shall comply with FCC Part 15, Subpart B 2019. Provide a communication interface for communication with the BCS. Controls shall be performed in a digital manner using the digital signal from the microprocessor based controller, converted through electronic

circuitry for modulation of actuators. Each BCS controller shall be expandable by adding additional input/output modules that operate through the processor of the BCS controller. The master processor in the BCS controller shall be able to manage remote field interface units thereby expanding its control loop and energy management point capacity. Each BCS controller including associated input/output modules shall have a minimum of 10% spare input and output points of each type installed. The BCS controller shall be supplied with a minimum of 8 hours of battery back-up for the clock operation and memory retention with an automatic battery charger. Provide interface for valve and damper actuators. BCS controller hardware shall provide relay or solid state isolation on each contact input circuit and each output circuit to prevent high voltage surges from entering the logic circuits.

1. Provide a digital display unit, programmed to display analog variables, binary conditions, off-normal conditions and other analog or binary information for analysis and adjustment of the system being controlled. The display unit shall provide visible indication of automatic operation, manual or override operation, a test and associated trouble indication, and alarm indication. The display unit shall include a keyboard containing keys to call-up the described point and type of value to be displayed and several special dedicated keys for such functions as manual-automatic, test and function and value enter, as an aid to the operator. This display unit may be furnished either as an integral component of the BCS controller or as a separate portable unit providing equivalent functions.
2. Provide manual hand-off-automatic (HOA) override switches and means for manually adjusting the analog output of outputs connected to each BCS controller. HOA switches and manual adjustments shall be either of a key operated design with switches keyed alike and utilizing the same keying system used for other outputs, or otherwise protected from unauthorized access by a key locked enclosure. An auxiliary set of contacts rated for at least 120 V AC, 1 A shall be provided as an integral part of each switch.
3. BCS controllers shall be arranged as indicated on the Drawings and installed to allow controllers to share global data. This global data shall include, but not be limited to: time-of-day, outside air temperature and humidity, and electrical meter and demand information. If BCS controllers are not configured in a communication network to share this data, then each BCS controller shall be provided with sensor inputs to implement sequences indicated on the Drawings when operating in a stand-alone mode.

C. Terminal Unit Controllers:

1. Control of terminal units shall be accomplished by microprocessor-based stand-alone terminal unit controllers utilizing direct digital control. An individual terminal unit controller shall be provided for each terminal unit and shall interface to the BCS. Wireless space temperature sensors are not allowed. Terminal unit controller components shall be furnished to the terminal unit manufacturer for factory mounting and calibration. Terminal unit controller power shall be 24 V AC. Each terminal unit controller shall contain resident programs which are field-selectable for a specific application. Resident programs shall be contained in nonvolatile memory using EEPROM, EPROM, or RAM. Systems that employ volatile (RAM) memory shall provide 72 hour battery back-up for each terminal unit controller. Temperature setpoints for heating and cooling and night setback shall be independent of each other and shall provide a zero energy band between heating and cooling modes.
2. Each terminal unit controller shall be accessible for purposes of control parameter and setpoint adjustment and monitoring from the BCS. An operator's terminal connected to any BCS controller on the network shall have access to all terminal unit controllers.

2.4 SERVERS

A. Central Server:

1. The Contractor shall provide a central server. The server shall support all NACs and BCS controllers connected to the customer's network whether local or remote.
2. Remote connections will be available via a virtual private network (VPN) through a Web interface.

3. It shall be possible to provide access to NACs via a single connection to the server. In this configuration, each NAC can be accessed from a remote graphical user interface (GUI) or from a standard Web browser by connecting to the server.
4. The server shall provide the following functions, at a minimum:
 - a. Global data access: the server shall provide complete access to distributed data defined anywhere in the system.
 - b. Distributed control: the server shall provide the ability to execute global control strategies based on control and data objects in any NAC in the network, local or remote.
 - c. The server shall include a master clock service for its subsystems and provide time synchronization for NACs.
 - d. The server shall accept time synchronization messages from trusted precision atomic clock internet sites and update its master clock based on this data.
 - e. The server shall provide scheduling for NACs and their underlying field control devices.
 - f. The server shall be capable of providing demand limiting that operates across all NACs. The server shall be capable of multiple demand programs for sites with multiple meters and or multiple sources of energy. Each demand program shall be capable of supporting separate demand shed lists for effective demand control.
 - g. The server shall implement the BACnet Command Prioritization scheme (16 levels) for safe and effective contention resolution of commands issued to NACs.
 - h. Each NAC supported by the server shall have the ability to archive its log data, alarm data and database to the server, automatically. Archiving options shall be user-defined including archive time and archive frequency.
 - i. The server shall provide central alarm management for NACs supported by the server. Alarm management shall include:
 - 1) Routing of alarms to display, printer, e-mail and pagers.
 - 2) View and acknowledge alarms.
 - 3) Query alarm logs based on user-defined parameters.
 - j. The server shall provide central management of log data for NACs supported by the server. Log data shall include process logs, runtime and event counter logs, audit logs and error logs. Log data management shall include:
 - 1) Viewing and printing log data.
 - 2) Exporting log data to other software applications.
 - 3) Query log data based on user-defined parameters.
5. Server hardware requirements: Contractor shall coordinate the server hardware requirements with the Owner, and provide software and programming necessary.
6. Server hardware requirements: the server shall include the following, at a minimum, and include software and programming necessary for the BCS
 - a. Server System Minimum Requirements:
 - 1) The server/storage systems shall include sufficient capacity to meet the trending requirements specified herein. The system shall include a minimum of 1 TB usable storage in a RAID 6 configuration.
 - 2) The BCS software shall be installed on systems which meet or exceed the manufacturer's requirements as well as the requirements specified herein.
 - 3) Operating system: Windows Server 2012 or higher.
 - 4) Processor: Intel Dual Xeon 6 core, 2.0 GHz, E5-2620 CPU.
 - 5) System RAM: 16 GB DDR3.
 - 6) Network interface: two 10 Gbps RJ45 ports.
 - 7) Hard drives: SATA-II 7200 RPM enterprise class hard drives (hot-swappable) in RAID 6 configuration.
 - 8) Redundant power supply.
 - 9) Rack mountable.

- b. Monitor: provide a rack mountable 17" (diagonal) flat panel monitor with integral KVM switch and keyboard in sliding housing designed for mounting in a 19" EIA rack with the following minimum features:
 - 1) Mounted in 1 RU sliding housing.
 - 2) Imaging technology: LCD, 4:3 aspect ratio, NTSC.
 - 3) Native resolution: 1280 x 1024.
 - 4) Maximum resolution: 1280 x 1024.
 - 5) Screen size: 17" viewable.
 - 6) BCS emulation of the monitor.
 - 7) Integral keyboard.
 - 8) KVM ports: 1 SPHD-15 female.
 - 9) Dual interface support: PS/2 or USB keyboard and mouse data transfer from the switch to the computer.
 - 10) Multiplatform support: Windows 2000/XP/Vista, Mac 8.6 or higher, Linux Red Hat 7.1 or higher, and Sun Solaris.
 - 11) Computer ports: 8 HDB-15 female.
 - 12) Power requirements: 100 V to 240 V AC.
 - 13) Manufacturer: Raritan MCD-LED 17108.

2.5 WORKSTATIONS

- A. Desktop workstations: provide one desktop workstation. Each workstation shall consist of a computer, monitor, keyboard, UPS, other devices specified herein, communications equipment, data transmission network and software to provide central override control, reprogramming, status indication, alarm indication and other functions specified herein for the BCS.
 - 1. Computer: the workstation computer shall be provided to control operator input/output, data transmission to and from BCS and terminal unit controllers, and to perform software functions as specified herein. At a minimum, the workstation shall include software required to operate and program the BCS, and meet or exceed the BCS manufacturer's requirements. The system shall include the following, at a minimum:
 - a. Operating system: Windows 10 Professional or higher.
 - b. Processor: Intel Core i7 - 7700 or higher, 3.6 GHz.
 - c. System RAM: 16 GB DDR4.
 - d. Video card: PCI Express, DirectX 10.0 compliant with 1 GB DDR3 RAM (GeForce GT 640 series) with support for 4 monitors (2 DVI ports and 1 mini HDMI port).
 - e. Network interface: 1 Gbps (10/100/1000Base-T).
 - f. Hard disk space: 500 GB SATA.
 - 2. 30" (diagonal) widescreen panel monitors with the following minimum features:
 - a. Imaging technology: LCD, 16:10 aspect ratio, NTSC.
 - b. Brightness: 370 cd/m².
 - c. Native resolution: 2560 x 1600.
 - d. Maximum resolution: 2560 x 1600.
 - e. Screen size: 30" viewable.
 - f. Contrast ratio: 3000:1.
 - g. Response time: 8 ms (gray to gray).
 - h. Pixel pitch: 0.2505 mm.
 - i. Computer/video input support: DVI-D (24-pin digital DVI) and VGA (15-pin HD D-Sub (HD-15)).
 - j. Power requirements: 100 V to 240 V AC.
 - k. Manufacturer: Avigilon M4000, Dell UltraSharp 3008WFP, or HP ZR30w.
 - 3. Keyboard: standard type with dedicated function keys.

4. Uninterruptible power supply (UPS): self-contained type, designed for installation and operation at the workstation, sized to provide a minimum of 30 minutes of operation for the workstation equipment. Equipment connected to UPS shall not be affected in any manner by a power outage of a duration less than the rated capacity of the UPS. UPS shall be complete with necessary power supplies, transformers, batteries, and accessories and shall include visual indication of normal power operation, UPS operation, abnormal operation, and visual, audible and network notification of low battery power.

2.6 COMMUNICATIONS

- A. The BCS communications shall comprise control products, communication media, connectors, repeaters, hubs, and routers. Controller and operator interface communication shall conform to ASHRAE 135-2016. Install new wiring and network devices as required to provide a complete and workable control network. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.
- B. Each NAC and BCS controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.
- C. System shall support Web services data exchange with any other system that complies with XML (extensible markup language) and SOAP (simple object access protocol) standards specified by the Web Services Interoperability Organization (WS-I) Basic Profile 1.0 or higher. Web services support shall as a minimum be provided at the workstation or web server level and shall enable data to be read from or written to the system.
 1. System shall support Web services read data requests by retrieving requested trend data or point values (I/O hardware points, analog value software points, or binary value software points) from any system controller or from the trend history database.
 2. System shall support Web services write data request to each analog and binary object that can be edited through the system operator interface by downloading a numeric value to the specified object.
 3. For read or write requests, the system shall require user name and password authentication and shall support SSL (Secure Socket Layer) or equivalent data encryption.
 4. System shall support discovery through a Web services connection or shall provide a tool available through the operator interface that will reveal the path/identifier needed to allow a third party Web services device to read data from or write data to any object in the system which supports this service.

2.7 SOFTWARE

- A. Web-Based Graphical User Interface (GUI):
 1. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer, Google Chrome, Mozilla Firefox, or Safari. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers are not acceptable.
 2. The Graphical User Interface (GUI) will support HTML5 enabled browsers without requiring proprietary operator interface and configuration programs or browser plug-ins.
 3. Graphic screens shall be capable of supporting Scalable Vector Graphics (SVG).
 4. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the FMCS, are not acceptable.
 5. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the GUI (if

- used). Systems that require different graphic views, different means of graphic generation, or that require different means of interacting with objects such as schedules, or logs, are not permitted.
6. Real-time displays: GUIs shall, at a minimum, support the following graphical features and functions:
 - a. Graphic screens shall be capable of being developed using any drawing package capable of generating a GIF, BMP, or JPG file format. Use of proprietary graphic file formats shall not be required. In addition to, or in lieu of, a graphic background the GUI shall support the use of scanned pictures.
 - b. Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URLs, and links to other graphic screens.
 - c. Graphics shall support layering and each graphic object shall be configurable for assignment to a layer. A minimum of 6 layers shall be supported.
 - d. Modifying common application objects, such as schedules, calendars, and setpoints shall be accomplished in a graphical manner.
 - 1) Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
 - 2) Holidays shall be set by using a graphical calendar without requiring any keyboard entry from the operator.
 - e. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No text entry shall be required.
 - f. Adjustments to analog objects, such as setpoints, shall be done by right-clicking the selected object and using a graphical slider to adjust the value. No text entry shall be required.
 - g. All Niagara AX native graphics as well as all HTML5 non-native graphics supported by Niagara 4.
 7. System configuration: at a minimum, the GUI shall permit the operator to perform the following tasks, with proper password access:
 - a. Create, delete, or modify control strategies.
 - b. Add or delete objects to the system.
 - c. Tune control loops through the adjustment of control loop parameters.
 - d. Enable or disable control strategies.
 - e. Generate hard copy records or control strategies on a printer.
 - f. Select points to be alarmable and define the alarm state.
 - g. Select points to be trended over a period of time and initiate the recording of values automatically.
 8. On-line help: provide a context sensitive on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for the currently displayed screen. Additional help information shall be available through the use of hypertext. System documentation and help files shall be in HTML format.
 9. Security: each operator shall be required to log on to the system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off the system if no keyboard or mouse activity is detected for a specified time. This auto log-off time shall be set per operator password. System security data shall be stored in an encrypted format.
 10. System diagnostics: the system shall automatically monitor the operation of workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
 11. Alarm Console:

- a. The system shall be provided with a dedicated alarm window or console. This window shall notify the operator of an alarm condition and allow the operator to view details of the alarm and acknowledge the alarm. The use of the alarm console may be enabled or disabled by the system administrator.
 - b. When the alarm console is enabled, a separate alarm notification window will supersede other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and unacknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator are not acceptable.
12. The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to set a specific home page for each user. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
13. Graphic screens on the Web browser client shall support hypertext links to other locations on the internet or on intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.
14. Graphics: the monitor display format shall be organized to permit the output of displays, and/or summaries specified herein, while concurrently displaying the most recent change-of-state occurrence.
 - a. The format shall also include in a dedicated and protected area of the viewing screen, the current user of the monitor, date, time, and program day. The monitor shall output advisories in a dedicated and protected area of the viewing screen and an appropriate display in the event of control system hardware malfunction or restoration.
 - b. Graphic displays for systems and system components shall be provided as indicated in the I/O summaries.
 - 1) The operator shall be capable, upon command entry, of calling for graphic displays of systems or zones.
 - 2) Displays shall contain flow schematics, and schematics of mechanical duct and piping systems, electrical switchgear, electrical distribution systems, pumps, fans, valves, dampers, chillers, boilers, coils, pull stations, smoke detectors, heat detectors, circuit breakers, engine-generator sets, and cooling towers for systems indicated in the I/O summaries to have graphic display.
 - 3) Displays shall include scaled building floor plans with air handling unit and terminal unit temperature control zones identified and space sensors indicated.
 - 4) Displays shall indicate values or status of I/O points associated with that system and those shall be dynamically updated at least once every 10 seconds. Software shall be provided to allow operator modification of graphic displays provided with the system and to allow operator creation and storage of new graphic displays.
 - 5) For each air handling unit provide a tabular graphic summary of that unit and its associated air distribution system. Graphics shall contain, at a minimum, the following information:
 - a) Supply fan's current operating speed and setpoint.
 - b) Manual adjustment of supply fan speed.
 - c) Supply air static pressure and temperature.
 - d) For each associated terminal unit, as appropriate:
 - (1) Minimum, maximum, and current airflow.
 - (2) Current damper position or command.
 - (3) Current associated space temperature.
 - (4) Current reheat valve position or command.
 - e) A commandable override point to place associated terminal units at maximum airflow.
 - f) A commandable override point to place associated terminal units at minimum airflow.

- 6) For each hydronic system, provide a tabular graphic summary of the primary equipment for that system and its associated air distribution system. Graphics shall contain, at a minimum, the following information, as required by the system's I/O summary.
 - a) Supply and return water temperatures and flows.
 - b) Distribution pump's current operating speed and setpoint.
 - c) Distribution system controlling differential pressure.
 - d) Manual adjustment of distribution pump's speed.
 - e) For each associated air handling unit or consuming equipment, as appropriate:
 - (1) Current valve position or command.
 - (2) Current associated discharge air temperature.
 - (3) A commandable override point to place associated terminal units at maximum reheat flow.
 - f) A commandable override point to place associated consuming equipment at full flow.
 - g) A commandable override point to place associated consuming equipment at no flow.

B. System Tools:

1. System Configuration Tools:

- a. The workstation GUI software shall provide the ability to perform system programming and graphic display engineering as part of a complete software package. Access to the programming functions and features of the GUI shall be through password access as assigned by the system administrator.
- b. A library of control, application, and graphic objects shall be provided to enable the creation of applications and user interface screens. Applications shall be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. GUI screens shall be created in the same fashion. Data for the user displays shall be obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property shall be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface displays are not acceptable.
- c. Programming Methods:
 - 1) Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user's application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links shall vary in color depending on the type of link, i.e., internal, external, hardware, etc.
 - 2) Configuration of each object shall be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration is not acceptable.
 - 3) The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real-time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.

- 4) Programming shall be done in real-time. Systems requiring the uploading, editing, and downloading of database objects are not acceptable.
- 5) The system shall support object duplication within a customer's database. An application, once configured, shall be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

2. Library:

- a. A standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.
- b. The objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.
- c. In addition to the standard libraries specified here, the supplier of the system shall maintain an on-line accessible (over the internet) library, available to registered users to provide new or updated objects and applications as they are developed.
- d. Control objects shall conform to the control objects specified in the BACnet specification.
- e. The library shall include applications or objects for the following functions, at a minimum:
 - 1) Scheduling object: the schedule shall conform to the schedule object as defined in the BACnet specification, providing 7-day plus holiday and temporary scheduling features and a minimum of 10 on/off events per day. Data entry shall be by graphical sliders to speed creation and selection of on-off events.
 - 2) Calendar object: the calendar shall conform to the calendar object as defined in the BACnet specification, providing 12-month calendar features to allow for holiday or special event data entry. Data entry shall be by graphical "point-and-click" selection. This object shall be "linkable" to scheduling objects for effective event control.
 - 3) Duty cycling object: provide a universal duty cycle object to allow repetitive on/off time control of equipment as an energy conserving measure. Any number of these objects shall be created to control equipment at varying intervals.
 - 4) Temperature override object: provide a temperature override object that is capable of overriding equipment turned off by other energy saving programs (scheduling, duty cycling, etc.) to maintain occupant comfort or for equipment freeze protection.
 - 5) Start-stop time optimization object: provide a start-stop time optimization object to provide the capability of starting equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Object shall also allow equipment to be stopped before the scheduled un-occupancy time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of start/stop time object properties based on the previous day's performance.
 - 6) Demand limiting object: provide a comprehensive demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, and gas). The object shall provide the capability of monitoring a demand value and predicting (by use of a sliding window prediction algorithm) the demand at the end of the user defined interval period (1-60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment setpoints to effect the desired energy reduction. If the list of sheddable equipment is not enough to reduce the demand to below the setpoint, a message shall be displayed on the users screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists shall be specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse

order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to effect both equipment protection and occupant comfort.

- f. The library shall include control objects for the following functions. Control objects shall conform to the objects as specified in the BACnet specification.
- 1) Analog input object: comply, as a minimum, with the BACnet standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time delay filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.
 - 2) Analog output object: comply, as a minimum, with the BACnet standard for data sharing.
 - 3) Binary input object: comply, as a minimum, with the BACnet standard for data sharing. Users shall be able to specify either input condition for alarming. This object shall also include the capability to record equipment run-time by counting the amount of time the hardware input is in an "on" condition. Users shall be able to specify either input condition as the "on" condition.
 - 4) Binary output object: comply, as a minimum, with the BACnet standard for data sharing. Properties to enable minimum on and off times for equipment protection as well as interstart delay shall be provided. The BACnet Command Prioritization priority scheme shall be incorporated to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide 16 levels of priority as a minimum. Systems not employing the BACnet method of contention resolution are not acceptable.
 - 5) PID control loop object: comply, as a minimum, with the BACnet standard for data sharing. Each individual property shall be adjustable as well as be disabled to allow proportional control only, or proportional with integral control, as well as proportional, integral and derivative control.
 - 6) Comparison object: allow a minimum of 2 analog objects to be compared to select either the highest, lowest, or equality between the 2 linked inputs. Object shall also allow limits to be applied to the output value for alarm generation.
 - 7) Math object: allow a minimum of 4 analog objects to be tested for the minimum or maximum, or the sum, difference, or average of linked objects. Object shall also allow limits to be applied to the output value for alarm generation.
 - 8) Custom programming objects: provide a blank object template for the creation of new custom objects to meet specific user application requirements. This object shall provide a simple BASIC-like programming language that is used to define object behavior. Provide a library of functions including math and logic functions, string manipulation, and e-mail as a minimum. Also, provide a comprehensive on-line debug tool to allow complete testing of the new object. Allow new objects to be stored in the library for re-use.
 - 9) Interlock object: provide an interlock object that provides a means of coordination of objects within a piece of equipment such as air handling units or other similar types of equipment. An example is to link the return fan to the supply fan such that when the supply fan is started, the return fan object is also started automatically without the user having to issue separate commands or to link each object to a schedule object. In addition, the control loops, damper objects, and alarm monitoring (such as return air, supply air, and mixed air temperature objects) shall be inhibited from alarming during a user-defined period after startup to allow for stabilization. When the air handling unit is stopped, the interlocked return fan shall also be stopped, the outside air damper shall be closed, and other related objects within the air handling unit shall be inhibited from alarming thereby eliminating nuisance alarms during the off period.
 - 10) Temperature override object: provide an object whose purpose is to provide the capability of overriding a binary output to an "On" state in the event a user specified high or low limit value is exceeded. This object shall be linked to the desired binary

- output object as well as to an analog object for temperature monitoring, to cause the override to be enabled. This object shall execute a Start command at the Temperature Override level of start/stop command priority unless changed by the user.
- 11) Composite object: provide a container object that allows a collection of objects representing an application to be encapsulated to protect the application from tampering, or to more easily represent large applications. This object shall have the ability to allow the user to select the appropriate parameters of the "contained" application that are represented on the graphical shell of this container.
- g. The object library shall include objects to support the integration of devices connected to the NAC. At a minimum, provide the following as part of the standard library included with the programming software:
- 1) For devices not conforming to the LonMark standard, provide a dynamic object that can be assigned to the device based on network variable information provided by the device manufacturer. Device manufacturer shall provide an XIF file, resource file and documentation for the device to facilitate device integration.
 - 2) For BACnet devices, provide the following objects at a minimum:
 - a) Analog in.
 - b) Analog out.
 - c) Analog value.
 - d) Binary.
 - e) Binary in.
 - f) Binary out.
 - g) Binary value.
 - h) Multistate in.
 - i) Multistate out.
 - j) Multistate value.
 - k) Schedule export.
 - l) Calendar export.
 - m) Trend export.
 - n) Device.
 - 3) For each BACnet object, provide the ability to assign the object a BACnet device and object instance number.
 - 4) For BACnet devices, provide the following support at a minimum:
 - a) Segmentation.
 - b) Segmented request.
 - c) Segmented response.
 - d) Application services.
 - e) Read property.
 - f) Read property multiple.
 - g) Write property.
 - h) Who-has.
 - i) I-have.
 - j) Who-is.
 - k) I-am.
 - l) Media types.
 - m) BACnet IP Annex J.
 - n) MS/TP.
 - o) BACnet Broadcast Management Device (BBMD) function.
 - p) Routing.

C. BCS Software:

1. General: provide global synchronization of BCS controller clocks and global coordination of BCS controller activity. Standard utility software packages shall be contained in memory including self-

test diagnostics and on-line memory diagnostics. System displays (hard and soft copy) shall be in plain English. Field selected control and monitoring points shall be capable of being described using operator selected menu penetration techniques. Values shall be described in appropriate units. The system shall have at least 3 user access levels. Menus and screens shall be organized to present orderly information. The system shall perform the following functions:

- a. Operator communication with any BCS and terminal unit controller including programming and data acquisition.
 - b. Full English operator display, including appropriate engineering units for variable data.
 - c. Power Failure and Automatic Restart:
 - 1) Power failure recovery: when recovering from a failure of the normal power supply, the system shall automatically:
 - a) Initialize the time of day within the real-time operating system.
 - b) Adjust time dependent parameters within the monitoring and control software.
 - c) Automatically restart and output a message indicating that a power failure occurred with the time and date of occurrence. A system restart shall initialize processors and communications, update time programs, and reset equipment to the appropriate operating status for the correct time.
 - d. System displays shall be capable of being randomly configured with any point assigned to any system for display/logging, independent of its hardware location.
 - e. Remote status to allow the operator to display on the monitor any point noting point description and engineering value.
 - f. System function to allow operator to update time and date.
 - g. Upload/download to transfer database to/from disk or diskette storage to/from BCS or terminal unit controller.
 - h. Edit/create database to configure, edit, create or delete database information in whole or in part.
 - i. Database error checking to provide a method of detecting and annunciating discrepancies that would prevent the system from full normal operation.
 - j. Whenever a field point status exceeds preset limits, or there are other indications of system exceptions, alarms, error or failures, there shall be at least the following indications:
 - 1) Audible tone: the system shall have an integral audible tone. The audio tone shall be capable of being enabled or disabled on operator command.
 - 2) Display: the alarm point identification shall appear on the monitor and print out along with individual point alarm messages. Upon operator command, alarms resident in the CCU shall be hard copy printed along with individual point alarm messages.
 - 3) Automatic dial out: the system shall automatically initiate calls to up to 4 telephone numbers on a rotating basis. Only those alarms selected by the Owner during BCS training shall initiate automatic dial out features.
2. System programming: controller software and custom programming shall be provided to implement control sequences as indicated on the Drawings. Each BCS controller shall contain mathematic, logic, utility functions and standard energy calculations and control functions in ROM to be available in any combination for field programming the unit. These routines shall include but not be limited to:
- a. Math Routines:
 - 1) Basic arithmetic.
 - 2) Binary logic.
 - 3) Relational logic.
 - b. Utility Routines:
 - 1) Process entry and exit.
 - 2) Variable adjustments and output.

- 3) Alarm indication.
 - 4) Restart.
 - c. Control Routines:
 - 1) Signal compensation.
 - 2) Loop control.
 - 3) Energy conservation.
 - 4) Timed programming.
 - d. Energy Management Routines:
 - 1) Scheduled start-stop and holiday programming.
 - 2) Optimal start-stop.
 - 3) Duty cycling.
 - 4) Demand limiting.
 - 5) Day-night setback.
 - e. Terminal Unit Control:
 - 1) Volume control in response to temperature.
 - 2) Volume flow limits, minimum and maximum.
 - 3) Occupied and unoccupied operation with associated temperature. and volume limits.
 - 4) Occupant temperature adjustment.
 - 5) Temperature setpoint override.
 - 6) Occupant override.
 - 7) Global reset of temperature and volume limits.
 - f. Project tailored programs: the library of routines available in firmware shall be capable of generating additional programs for specific Project requirements. These should include but not be limited to:
 - 1) Chiller efficiency.
 - 2) Supply air temperature control.
 - 3) Variable volume supply fan control.
 - 4) Space temperature control.
 - 5) Fire alarm activated sequences.
 - 6) Totalizing.
 - 7) Event initiated sequences.
3. Each BCS controller shall perform its full control and energy management functions, regardless of the condition of the communications link with other system components. These stand-alone capabilities shall be implemented and shall include, but not be limited to, closed loop control functions (P, PI, PID, incremental, floating) and energy management functions. BCS controllers and terminal unit controllers shall be totally stand-alone and independent of other components of the BCS for control applications specified herein. Failure of other components of the BCS shall in no way inhibit the operation or program execution of BCS controllers and terminal unit controllers.
4. BCS controller control algorithms shall be available and resident in the BCS controller to permit proportional, integral and derivative control modes in any combination to meet the needs of the application. Other control modes, incremental, floating or 2-position, shall be available to adapt to the needs of the Project. Adjustment of control variables shall be available at the BCS controller through the display unit. These adjustments shall include, but not be limited to, proportional gain, integral rate, the velocity and acceleration constants associated with incremental control, and on/off values of 2-position control. Each control loop setpoint and control logic threshold shall be programmed as a variable expressed in the appropriate engineering units and shall be displayable and adjustable through the display unit. Modification of BCS software shall not be required to alter those variables.
5. Software, local variables, and data resident in the BCS controllers shall be resident in nonvolatile memory or shall be down-loadable from the BCS.

D. Energy Management Software:

1. Scheduled start-stop and holiday programs: provide software to start and stop equipment based on the time-of-day for each day-of-week, including holidays. To eliminate power surges and to ensure stable system operation, an operator adjustable time delay shall be provided between consecutive start commands and between consecutive stop commands for electrical loads. Software shall provide for multiple start/stop events scheduled for each output for each day, including holidays.
2. Optimum start-stop program: provide software to start and stop equipment on a sliding schedule based on indoor and outdoor air conditions. The program shall take into account the thermal characteristics of the structure, indoor and outside conditions using prediction software to determine the minimum time of system operation needed to satisfy space environmental requirements at the start of the occupied cycle, and determine the earliest time for stopping equipment at the day's end. The program shall automatically modify the calculation constants based on its past performance.
3. Demand limiting program: provide software to shed electrical loads to prevent exceeding an electrical demand peak value (target). The program shall continuously monitor power demand, and with prediction software, calculate a predicted power demand. When the predicted power demand exceeds a preset desired target, the program shall turn off or adjust operation of electrical loads on a prescheduled priority basis to reduce the connected load before the actual peak exceeds the target. The demand limiting program shall provide several priority levels of loads. Loads in the lowest priority level shall be shed before loads in the next higher priority level. Loads shed within a priority level shall be rotated automatically, subject to equipment constraints to avoid any one load from always being shed first. Loads shed in the highest priority level shall be restored before loads in lower priority levels. The demand program shall be compatible with time-of-day metering. The program shall permit a minimum of 6 individually resettable time-of-day demand periods in 24 hours. The start and stop time of each time-of-day demand program shall allow different daily schedules for 3 types of days (weekday, weekend, holiday). A time-of-day metering calendar shall be established by the program which shall define daily time-of-day metering schedules.
4. Day-night setback program: provide software to limit the rise or drop of space temperature during unoccupied hours. Whenever the space temperature is above (or below for heating) the operator assigned temperature limit, the system shall be enabled until the temperature is within the assigned temperature limit.
5. Power fail-auto restart: on power failure, the BCS controller shall shutdown without damage to the BCS controller or connected systems, and without loss of programmed information. If power is restored within the time specified herein for battery back-up of BCS controller clock operation, the BCS shall automatically restart, adjust operating parameters according to the proper time of day, and resume full normal operation within no longer than 5 minutes following restoration of power. Each controlled item of equipment 5 hp or greater shall be sequentially restarted or returned to proper operation as appropriate for the time-of-day.
6. Event initiated sequences: based on programmable values of either digital or analog inputs or outputs, the BCS controller shall be able to open or close any output contacts or combination of contact outputs, and adjust any analog output over its normal range.
7. Terminal unit controller software: provide software for the management and control of the BCS terminal unit controllers. Software shall allow for operator definition of terminal unit controllers as functional groups; monitoring, alarming and reporting of terminal unit parameters on an individual or group basis; after hours terminal unit operation monitoring and reporting on an individual or group basis; and remote setpoint adjustment of terminal unit parameters on an individual or group basis in response to operator commands or through software interaction.
8. Chiller demand limit program: provide software to limit maximum available chiller electrical demand. Each adjustable chiller demand control step shall be assigned an equipment priority level in the demand limiting program.

- E. Trending and reporting: a utility software data file log package shall be provided that analyzes and formats, into English language, a hard copy printout of hardware and software configurations of the system. This package shall be designed to allow the operator to select individual data file logs specified herein. This software package shall be executable via the BCS to allow site hard copy documentation of current data file caused by system modifications and schedule changes.

1. System configuration log: data file logs shall document basic system parameters, individual channel configuration with listing of type of hardware used with its assigned system address, listing of peripheral device (printer and operator terminals) and address with its associated segregation as to function.
2. Individual point parameter log: this software package shall provide a detailed listing of system points with the following information:
 - a. Digital points: point address, assigned engineering units, type of point, listing of which programs the point is used in the system.
 - b. Analog points: point address, engineering units, assigned scale factor, offset, decimal position of value, and a listing of which programs the point is used in the system.
3. System program data file log: provide to document details on individual application programs as listed below:
 - a. Time program log of programs, or selected programs, listing program number and on and off times assigned for each individual day of the week.
 - b. A listing of points grouped by initiating devices causing a change in condition. For example, a listing of points scheduled on by a fixed time schedule.
 - c. Printout listing individual calculation address with its assigned operators and parameters. Also, a listing of other calculation points using its results.
4. Alarm summary: an alarm summary shall be provided which contains the point status of points in the alarm condition.
5. Trend log: a program shall be provided which outputs a log on a time interval basis. This program shall provide the operator with the ability to place a minimum of 16 points on trend logs and the ability to assign the trend interval from 1 second to 99 minutes. Adding, changing, or deleting a trend point, assigning the trend log period, or outputting the trend log shall be performed without any loss of change-of-state reporting on the designated hard copy device. Trend log report information shall be listed in vertical columns. A directory of columnar placement shall appear in the heading of the trend log.
6. Historical data file storage: the system shall provide software to allow operator designation of point values or status to be automatically stored in historical files on the hard disk of the BCS central computer. Software shall allow operator designation of which point data is to be stored, at what frequency it is to be stored, when to start and when to stop storing the data, and shall allow a minimum of 50 points to be assigned to the historical data function at one time.
7. Field generated reports: the system shall have the capability, as installed, to develop custom management report logs. The software shall be capable of displaying, organizing, and editing the historical data files of point data.
8. Custom reports: software and programming shall be included to generate the following reports on either a weekly or a monthly basis:
 - a. Chiller operation: for each chiller, report the number of chiller start commands, the total hours of operation, total chiller kWH consumption, average chiller kW input per ton for the report period, peak chiller tons, peak chiller kW demand and time of peak, and the number of chiller safety shutdowns. The chiller tons shall be calculated using the chilled water flow rate and evaporator entering and leaving water temperatures.
 - b. Boiler operation: for each boiler, report the consumption of gas and oil for the report period. Gas consumption shall be measured using a transducer to monitor the gas burner manifold pressure while the burner is in operation. Oil consumption shall be obtained by monitoring and totalizing the pulse contacts of the existing fuel oil meter pulse initiators, and subtracting the fuel return meter value from the supply meter value.
 - 1) Calculate the number of 65°F based degree hours during the period while the boilers were enabled, and report the average building heating energy consumption in Btu/(°F·h), using an energy value of 1050 Btu/ft³ for gas and 140000 Btu/gal for fuel oil.

- c. Smoke control system verification: for each smoke control system, a weekly test sequence shall verify the presence of power downstream of disconnects, positive confirmation of actuation, and confirmation that the system has not been manually overridden. Abnormal conditions shall be communicated via audible and visual alarms and a printed report.

2.8 SENSORS

A. BCS Sensors:

1. Provide sensors, controls, instruments, and control interfaces to meet the performance specified herein. Sensors shall be high quality precision electronic type, selected to be compatible with the BCS controllers and appropriate for the service specified herein. Accuracy values specified herein include sensor, wiring, signal conditioning and display accuracies for overall end-to-end performance. Sensors shall be selected to place the expected value in the middle third of the device's range.
2. Temperature sensors: 100 or 1000 ohm platinum resistance temperature device (RTD), Deutsche Industrial Norms (DIN) 43760, with an average percent change in resistance per degree (α) of 0.00385 ± 0.00002 ohms/ohm/ $^{\circ}\text{C}$, selected for normal range of media sensed with accuracy of $\pm 0.5^{\circ}\text{F}$ at 70°F except chilled water sensors used for Btu calculations or control as indicated on the I/O summaries shall have an accuracy of $\pm 0.25^{\circ}\text{F}$ at 32°F . Sensors used for Btu calculations shall be matched pairs at the calibration point. Temperature sensor stability errors shall not exceed 0.25°F cumulative over a 5 year period. Provide thermowells and insertion type sensors for water temperature sensing. Air temperature sensing shall be provided by duct insertion type sensors for supply or return duct temperatures and by extended element averaging type for plenum, and coil entering or leaving temperatures. RTD transmitters shall be a 2-wire, loop-powered device, producing a linear 4-20 mA output corresponding to the temperature span of the connected sensor. The output error shall not exceed 0.1% of calibrated span. Transmitters shall include noninteracting offset and span adjustments and RFI shielding and rejection circuitry to prevent disruption from ambient signals. Transmitter drift shall be less than 0.1°F per year.
3. Space temperature sensors: space temperature type with setpoint adjustment range of 45°F to 85°F . Wireless space temperature sensors are not allowed. The setpoint adjustment shall be locked out, overridden, or limited as to time or temperature in software from a central or remote operator's terminal. Precision thermistors may be used in space temperature sensing applications below 200°F . Sensor accuracy over the application range shall be minimum 0.5°F between the range of 32°F to 150°F including sensor error and A/D conversion resolution error. Sensor manufacturer shall utilize 100% screening to verify accuracy. Thermistors shall be pre-aged and inherently stable. Stability error of the thermistor over 5 years shall not exceed 0.25°F cumulative. Sensor element and leads shall be encapsulated. Bead thermistors shall not be used. Space temperature sensors shall include a communications port for local connection of a portable test/terminal device for communications/programming access to the associated BCS controller.
 - a. Covers:
 - 1) Unless otherwise specified herein, space temperature sensors shall have blank cover, visible temperature indicator integral to the sensor, and concealed means of setpoint adjustment.
 - 2) Space temperature sensors in operating rooms, labor and delivery rooms, and special procedure (radiology) rooms shall have covers with visible temperature indicator integral to the sensor, occupant override push button integral or adjacent to the sensor assembly, and accessible means of setpoint adjustment.
 - 3) Space temperature sensors in patient rooms shall have blank cover and accessible means of setpoint adjustment.
4. Humidity sensors: bulk polymer type, with self-contained 4-20 mA transmitter and replaceable element. Accuracy shall be $\pm 2\%$ RH in the range of 20% to 90%. The transmitter shall include noninteracting zero and span adjustments with an output error not exceeding 0.1% of calibrated

- span. Saturation shall not alter calibration. Sensors for space humidity shall have same appearance as space temperature sensors.
5. Pressure sensors: 2-wire strain gauge type, designed for media sensed for static pressure or differential pressure. The span shall be continuously adjustable from 0% to 125% of the expected full pressure or full flow differential pressure. The zero shall be continuously adjustable on outputs. Transmitters shall produce a 4-20 mA signal with an accuracy of $\pm 1.0\%$ of the upper range limit for 6 months from calibration. Instruments shall be capable of withstanding an overrange pressure limit of 300% normal.
 6. Current sensing relays: current sensing relays shall provide an adjustable setpoint normally open contact rated at a minimum of 50 V peak and 0.5 A or 25 VA, noninductive. There shall be a single opening for passage of current carrying conductors. Relays shall be sized for operation at 50% rated current based on the connected load. Voltage isolation shall be a minimum of 600 V.
 7. Filter status: filter status shall be sensed by 4-20 mA input from differential pressure gauges across each filter, as specified in Section 237000, Air Distribution.
 8. Water flow meters: turbine, insertion type, with isolation valve and packing gland for removal under full line pressure. Wetted parts shall be corrosion resistant. Range shall be from 3 fps to 30 fps with water as the medium. Accuracy shall be $\pm 3\%$ at any operating point. The flow meter signal conditioner shall output a 4-20 mA signal and shall provide zero and span adjustments. The conditioner enclosure shall be NEMA 4.
 9. Water Flow Meters:
 - a. Non-intrusive ultrasonic type, complete with enclosure, LCD display, transducers, mounting straps, and cables of a length suitable for the installation. Meter feature shall include:
 - 1) The ability to indicate flow rate, velocity, direction, total flow, supply water temperature, and return water temperature.
 - 2) Self and application diagnostics to isolate fault conditions to either equipment failure or abnormal process conditions.
 - 3) Automatic Reynold's number compensation.
 - 4) 0.2 to 40 fps range.
 - 5) Accuracy for flows greater than 1 fps shall be $\pm 1\%$ of flow rate. Repeatability shall be 0.5% of flow.
 - 6) Electronics housed in a NEMA 4X enclosure and powered by 24 V DC control power.
 - 7) Dual strap-on 1000 Ohm platinum RTD temperature sensors with a 32° to 212°F range and sensing cables of a length suitable for the installation.
 - 8) Indication of energy usage in BTU, MBTU, MMBTU, Tons, Kj, Kw, OR MW.
 - b. The Contractor shall coordinate the communications interface requirements necessary for the BCS to monitor energy usage, flow, velocity, supply water temperature, and return water temperature, and an alarm point to indicate whether the flow meter is in a fault condition. At a minimum, the following communications interfaces shall be provided:
 - 1) A BACNet/IP output.
 - 2) An isolated 4-20 mA DC output proportional to flow.
 - c. Manufacturer: NonContact Meters NCMB series NCME energy series.
 10. Building electrical meter: kilowatt-hour pulses shall be obtained from the building electrical meter. Provide current transformers, pulse initiators and equipment for interface of signals to the BCS. Components shall provide a minimum of 5 pulses per minute at 75% design load. System shall have separate input point for each kWh meter.
 11. CO sensors: electrochemical or solid state sensing elements, adjustable or selectable sensing range of at least 200 ppm. Sensor elements shall have a minimum operating life of 5 years in normal service, a maximum drift of no more than 0.5% per month, and a response time of no more than 30 seconds to a 90% of full scale change. Sensors and transmitters shall provide a 4-20 mA analog output proportional to sensed gas concentration.
 - a. Manufacturer: INTEC Controls, or Mine Safety Appliances.

2.9 MATERIALS

A. Actuators:

1. BCS terminal unit actuators: 24 V nonstall spring return type, providing complete modulating control for the full range of damper movement. Actuators shall be de-energized when the damper has reached the operator or system determined position. Actuators shall be supplied to the terminal unit manufacturer for factory mounting and calibration. Actuators shall be removable for servicing without removing the terminal unit. Actuators shall be provided with transformers for proper operation from the terminal unit controller power source.
2. Other actuators: 24 V electric worm-gear type, sized to provide required starting torque and control the driven apparatus smoothly. Higher voltage actuators are acceptable for specific applications where 24 V actuators are not adequate. Provide adjustable end switches for valve and damper open/closed monitoring where required by the control sequences or as specified herein. For control valves 4" and larger, provide actuators with visual position indicator, self-regulating heater for condensation control, motor thermal protection, and hand-wheel for manual override.
 - a. Actuators shall have spring return.
 - b. Actuators for outside air, exhaust air, and other openings to the outside shall have spring return.

B. Thermostats: nonconstant bleed relay or line voltage type and shall have adjustable throttling range with an accuracy of $\pm 1.0^{\circ}\text{F}$. Room type shall have blank cover with thermometer, and accessible concealed means of adjustment. Remote element type shall have accessible adjustment knob. Provide separable wells for elements in liquids and extended necks for wells in insulated pipe.

1. Low limit safeties: elements shall respond to the lowest temperature to which any 12" segment is exposed; minimum length 8'.
2. Averaging type: for use in coil discharge and mixed air locations.
3. Thermostats shall not contain mercury.

C. Thermostat guards: 22 gauge steel with lockable hinged cover and baked enamel finish. corrosion resistant wire mesh with lock.

D. Humidistats: same cover as room thermostats, with an accuracy of $\pm 5\%$.

E. Occupied/unoccupied switches: stainless steel coverplates with red pilot light. Coverplates shall be engraved with "Occupied/Unoccupied". Pilot light shall be on whenever switch is in the occupied position.

F. Manual push buttons: flush-mounted, in NEMA 1 enclosure with pilot light.

G. Control valves: brass-trimmed; 2" and smaller, bronze bodies with screwed connections; over 2", cast iron bodies with flanged connections. Steam valves operating at pressure differentials greater than 25 psig and water valves operating at pressure differentials greater than 40 psig shall have stainless steel trim and replaceable seat ring.

1. Valves shall be capable of full closure against 150% of design pump head, or a 50 psig differential pressure, whichever is greater.
2. Valves for water shall have equal percentage flow characteristics. Modulating control valves shall be sized for a pressure drop of 3 psig to 5 psig, unless indicated otherwise on the Drawings. Two-position valves shall be line size.
3. Ball valves used for modulating service shall have a replaceable flow characterizing disk to provide the required flow characteristics.
4. Steam valve sizes are indicated on the Drawings, and shall have linear characteristics.
5. Pressure/temperature rating: as specified in Section 231000, Piping, Valves and Accessories.
6. At the Contractor's option, control valves may be butterfly type for chilled and condenser water service in piping 2" and larger. for two-position applications only. Modulating butterfly valves shall

be sized for full flow pressure drop of 2 psig to 4 psig at 60% open and be limited to this opening. Two-position control valves shall be line size. Valves 8" and larger shall be provided with either worm-gear electric actuators or high pressure pneumatic actuators sized for 150% of the torque required to unseat the valve from the closed position. Valves shall be rated for bubbletight closure at a differential pressure equal to the valve body rating.

- H. Temperature regulators, self-contained: adjustable type with enclosed bellows, cadmium-plated spring, indexed spring adjustment guide, top mounted 3.5" diameter temperature indicator, sensing bulb and copper plastic-covered Teflon-covered capillary tubing. Capillary length shall be as required for the installation. Valves up to 2" shall have bronze body, screw pattern, and stainless steel trim, and shall be rated for 150 psig service. Valves 2.5" to 6" shall have cast iron body, 125 psig flanges, and stainless steel trim.
- I. Control dampers: single-blade up to 8" high, multiblade over 8" high; minimum 80% free area based on damper frame outside dimensions.
 - 1. Blades: minimum 16 gauge galvanized steel, or extruded aluminum. Blades shall be airfoil shape.
 - a. Pivot rods: steel, minimum 0.5" diameter or hex, with one rod extended 6" to permit operation of damper from outside the duct.
 - b. Maximum length 42"; maximum width 8".
 - c. At points of contact: interlocking or overlapping edges, and compressible neoprene or extruded vinyl blade seals, and compressible metal side seals designed for temperature of -40°F to 180°F at leakage rate specified herein.
 - d. Type:
 - 1) Opposed blade: for balancing and modulating applications.
 - 2) Parallel blade: for 2-position, and outside and return air mixing applications. For mixing applications, orient dampers to achieve maximum mixing at throttled conditions.
 - e. Maximum damper area per motor: 15 ft².
 - 2. Leakage when closed: less than 4 cfm/ft² at 1" wg differential static pressure based on a 48" damper width.
 - 3. Frames: galvanized steel bar minimum 2" wide x 12 gauge for dampers 10" high or less, and 3.5" x 0.875", 16 gauge galvanized roll-formed channel with double-thickness edges or 5" x 1" x 0.125" extruded aluminum channel for 11" high and larger.
 - a. Corner bracing.
 - b. Full size of duct or opening in which installed.
 - 4. Bearings: synthetic stainless steel sleeve type.
 - a. Thrust bearings: vertically mounted.
 - b. Maximum spacing: 42".
 - 5. Finish on steel parts: galvanized.
 - 6. Operating linkage: factory-assembled, concealed in frame out of airstream, steel construction.
- J. Panels: surface type cabinet with hinged front panel and cylinder lock. Panels shall utilize one master key.
- K. Wiring: low voltage control wiring shall be not less than #18 AWG, 600 V plastic covered, color-coded. Line voltage wiring shall be not smaller than #16 AWG, 600 V. Sensor wiring shall be not less than #20 AWG twisted, shielded.
- L. Valve tags: as specified in Section 230010, HVAC General.
- M. Labels: as specified in Section 230010, HVAC General.

- N. Thermometers:
1. Water: as specified in Section 231000, Piping, Valves and Accessories.
 2. Air: 5" diameter, bimetal type.
- O. Emergency fan shutdown stations: normally closed toggle switches mounted on a panel with a locked, transparent front cover. Panel shall show a system schematic showing each area, and have engraved labels for each switch. Submit detailed shop drawing of panel and labels for approval.
- P. Thermowells: monel, brass, or copper for use in water piping and stainless steel for other applications. Thermowells shall have threaded plug and chain, retaining nut, and lagging neck to clear insulation. Inside diameter of insertion neck shall accommodate the element being installed.
- Q. Time switches: 7 day electronic programmable microprocessor type, with a temporary override feature for over calling the off position and operating the system without resetting the program, and a 48 hour battery powered carryover for loss of power.
- R. Occupant override timers: 1 hour interval type for overcalling the time switch off position and operating the system on a temporary basis.
- S. Weather shield enclosures: NEMA 3R rated with transparent cover, sized for the device enclosed.
- T. Airflow measurement systems: provide complete UL listed assemblies to monitor airflow in ductwork and plenums at locations indicated on the Drawings. Each system shall be complete with one or more multipoint measuring probes, airflow sensors and a single microprocessor-based transmitter.
1. Probes: aluminum or stainless steel construction with mounting brackets. Probes shall be supported at both ends.
 2. Airflow sensors: designed to operate at velocities of 50 fpm to 5000 fpm, temperatures of -20°F to 140°F, and relative humidities of 0% to 99% (noncondensing). Each sensing point shall independently determine the airflow rate which shall be equally weighted and averaged by the transmitter prior to output.
 3. The minimum number of sensors for each assembly shall be as follows:

<u>Area, (ft²)</u>	<u>No. of Sensors</u>
1 to 4	4
4 to 8	6
8 to 12	8
12 to 16	12
>16	16

4. Transmitters: designed to operate at temperatures of -20°F to 120°F and provided with LCD display, 24 V AC power connection, and analog output signal (0-10 V DC or 4-20 mA) for connection to the BCS.
5. Accuracy: ±2% of reading over the entire operating airflow range.
6. Manufacturer: Ebtron, Fluid Components International, or Tek-Air.

2.10 AUXILIARY EQUIPMENT

- A. Transient surge suppressors: suppressors shall be solid state, operate bidirectionally, and have a turn-on and turn-off time of less than one nanosecond, and shall provide the protection specified herein, either as an internal part of the BCS controller or as a separate component. Suppressor manufacturer shall have available certified test data confirming a fail short failure mode.
1. Communication or Signal Conductor Transient Suppressors:

- a. Maximum single impulse current conductor-to-conductor or conductor-to-ground: 10000 A, 8 x 20 μ s waveform.
 - b. Pulse life rating: 3000 A, 8 x 20 μ s waveform, 2000 occurrences.
 - c. Maximum clamping voltage at 10000 A, 8 x 20 μ s waveform, with the peak current not to exceed the normal applied voltage by 200%.
- B. Uninterruptible power supply (UPS): provide a self-contained UPS designed for installation and operation at each BCS controller sized for at least 125% of the peak demand, and to provide a minimum of 15 minutes of full operation of the controller and input/output expansion modules connected to that controller. Equipment connected to the UPS shall not be affected in any manner by a power outage of a duration less than the rated capacity of the UPS. Each UPS shall be wired such that primary power to the controller will be maintained upon failure of the UPS, including either a relay switch upstream of the UPS or two UPSs in parallel. UPS shall be complete with necessary power supplies, transformers, batteries, and accessories and shall include visual indication of normal power operation, UPS operation, abnormal operation and visual and audible indication of low battery power, and shall provide a normally open alarm contact for monitoring by the BCS.

PART 3 - EXECUTION

3.1 GENERAL

- A. Where control devices are installed on insulated piping or ductwork, provide standoff brackets or thermowells sized to clear insulation thickness. Provide extended sensing elements, actuator linkages, and other accessories as required.
- B. Wiring and tubing shall be identified with the same numbers and symbols as used on the corrected, approved record diagrams.
- C. Label control apparatus with nameplates or tags bearing the functional designations shown on approved control diagrams.
- D. Where control devices are exposed outside the building, provide weather shield enclosures.

3.2 COMMISSIONING SUPPORT REQUIREMENTS

- A. Prepare a written plan indicating in a step-by-step manner the procedures that will be followed to test, check-out, and adjust the control system prior to beginning functional testing. Keep the Commissioning Authority informed of progress with the Project and of changes to the proposed installation, programming and test plan. At minimum, the plan shall include for each type of equipment controlled by the automatic controls:
 - 1. Step-by-step procedures for testing each type controller after installation, including:
 - a. Process of verifying proper hardware and wiring installation.
 - b. Process of downloading programs to load controllers and verifying that they are addressed correctly.
 - 2. Process of verifying proper hardware and wiring installation.
 - 3. Process of performing operational checks of each controlled component.
 - 4. Plan and process for calibrating valve and damper actuators and sensors.
 - 5. A description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.
 - 6. A copy of the log and field check-out sheets that will document the process. This log shall include a place for initial and final values read during calibration of each point and clearly indicate when a

- sensor or controller has passed and is operating within the contract parameters. Notification of any equipment failures shall be documented.
7. A description of the instrumentation required for testing, including a certification of calibration for each test instrument.
 8. Identify which tests and systems should be completed prior to using the control system for test, adjustment, and balance work.
- B. Provide the Commissioning Authority complete system logic diagrams, describing the proposed system programming, with programmed attributes shown. These diagrams shall be updated with field modifications from the start-up, check-out, and prefunctional testing prior to the beginning of the functional testing of the BCS. Provide a copy of each proposed graphical interface screen with interface points shown for the entire system.
- C. Prefunctional tests: verify and document the proper installation, addressing, calibration, programming, operation, and failure mode of BCS control points, sequences, and equipment. Provide a signed and dated certification to the Commissioning Authority and Owner upon completion of the check-out of each controlled device, equipment, and system that installation, set-up, adjustment, calibration, and system programming is complete as specified herein and as indicated on the Drawings, except functional testing. Completed prefunctional documentation of the system verification shall be submitted to the Commissioning Authority for review and approval prior to the functional testing of the BCS or its being used in the testing of other equipment or systems, or other purposes. Copies of final field check-out sheets and trend logs shall be provided to the Commissioning Authority for inclusion in the Commissioning Report.
- D. Functional tests: conduct and document a functional test of the complete installed BCS, as defined in Section 230090, Performance Verification. Functional testing of the BCS may be conducted in phases or sections, as defined by the requirements of the Functional Test, or as approved by the Commissioning Authority. The BCS, or applicable portions of the system, shall have completed functional testing and be approved by the Commissioning Authority before being used for other purposes, such as test and balance measurements, or in support of the functional testing of other systems.
1. Assist in the functional testing of equipment and systems by implementing trend logs and equipment monitoring as specified herein and as required by Section 230090, HVAC Performance Verification.
- E. Meet with the testing, adjusting, and balancing contractor prior to beginning the test, adjustment, and balance process and review the test, adjusting, and balancing plan to determine the capabilities and requirements of the control system in completing the testing, adjusting, and balancing process. Provide the testing, adjusting, and balancing contractor any needed unique instruments for setting terminal units and instruct the testing, adjusting, and balancing contractor personnel in their use. Assist and cooperate with the testing, adjusting, and balancing contractor by providing a qualified technician to operate the controls as required to assist the testing, adjusting, and balancing contractor in performing his work, or alternatively, provide sufficient training for the testing, adjusting, and balancing contractor to operate the system without assistance. Verify the proper operation of affected controls at the completion of the test, adjustment, and balance procedure.
- F. Seasonal Adjustment:
1. Assist the Commissioning Authority with the seasonal adjustment process. During this effort the Commissioning Authority will:
 - a. Check and verify the calibration of temperature control devices and thermostats. Test and verify control sequences for proper operation for the season.
 - b. Where deficient operation or defective equipment is discovered, provide corrective measures as required by the warranty provisions specified herein.

3.3 BCS

A. BCS Failure Mode:

1. BCS controls and interfaces shall be arranged so that equipment controlled by the BCS operates as indicated on the I/O summaries on failure of the BCS controller for any reason, including logic power supply failure, CPU lock-up, or interposing relay failure. Safety and operational interlocks shall remain in effect.

B. Control sequences for fire alarm system signal responses shall be independent of the BCS controller and its outputs.

C. Modify the existing BCS software to include new systems specified herein. Provide graphic displays for systems and systems components as indicated in the I/O summaries.

D. Transient surge suppressors: install on low voltage signal or communications conductors entering the building from exterior locations, including those conductors from devices mounted on the exterior of the building. In addition, provide AC voltage power transient suppressors for BCS equipment power supplies.

E. The BCS desktop workstation shall be provided by the Owner

F. BCS Sensors:

1. Liquid temperature sensors: fill sensor wells with thermally conductive material to assure accurate readings.
2. Current sensing relays: fan and pump status shall be sensed by a current sensing relay wired on the load side of each fan and pump. For constant speed fans and pumps, the current sensing relay trip setpoint shall be set at the motor's normal operating speed. For variable speed fans and pumps, the current sensing relay trip setpoint shall be set for the lowest operating speed, as determined by the commissioning process (typically 20%).
3. Proper calibration of sensors shall be demonstrated and documented as part of the commissioning process.
4. Sensor calibration: calibration of sensors shall be included as part of the prefunctional checklists according to the following procedures:
 - a. General: verify that sensors with shielded cable are grounded only at one end.
 - b. Sensors without external transmitters: take a reading with a calibrated test instrument within 6" of the sensor installation and verify the sensor reading is within the specified tolerance. If not, install offset, calibrate, or replace sensor to obtain required accuracy.
 - c. Sensors with external transmitters: disconnect sensor from transmitter input and connect a signal generator in place of sensor. Using manufacturer's data, simulate minimum measured value. Adjust transmitter potentiometer zero until minimum signal is read. Repeat for the maximum measured value and adjust transmitter until maximum signal is read. Reconnect sensor. Make a reading with a calibrated test instrument within 6" of the sensor installation. Verify that the sensor reading is within the specified tolerance. If not, repeat process until specified accuracy is achieved, or replace the sensor and repeat process.
 - d. Paired sensors: for sensor pairs that are used to determine a temperature or pressure difference, calibrate both sensors to a common measurement and verify they are reading within $\pm 0.25^{\circ}\text{F}$ for temperature and within a tolerance equal to $\pm 2\%$ of the sensor reading for pressure.

G. BCS Start-up and Check-out:

1. Provide the services of control technicians at start-up to check-out the system, verify and calibrate sensors and outputs, input data supplied by the Owner, and place the system in operation. Verify proper operation of each item in the sequences of operation, including hardware and software.

2. Check-out each system for control function through the entire sequence. Check actuator travel on dampers and valves for action and extent. Verify that control dampers and valves open and close completely. Check calibration of instruments. Calculate and verify instrument setpoints.
3. Calibration and testing: calibrate sensors and monitoring inputs and verify proper operation of outputs before the system is placed on-line. Check each point within the system by making a comparison between the operator console and field device. BCS control loops, failure modes, interlocks, sequences, energy management programs, and alarms shall be debugged, tested, and stable operation verified. Control loop parameters and tuning constants shall be adjusted to produce accurate, stable control system operation. Before obtaining permission to schedule the acceptance test, provide written documentation of system calibration and certification that the installed complete system has been calibrated, verified, and is ready to begin testing.

H. BCS Acceptance Conditions:

1. Acceptance test: conduct final acceptance test, with the Owner on site, on the complete and total installed and operational system to demonstrate that it is functioning in accordance with requirements specified herein. Demonstrate the correct operation of monitored and controlled points as well as the operation and capabilities of sequences, reports, specialized control algorithms, diagnostics, and software.
2. System shall demonstrate the following minimum acceptable levels of performance, within the physical limitations of the controlled equipment:
 - a. Control loops shall maintain stable, nonhunting, nonoscillating control, with minimum overshoot in response to transient and upset conditions.
 - b. Space and air temperatures shall be maintained within $\pm 1^{\circ}\text{F}$ of setpoint.
 - c. Humidity shall be maintained within $\pm 5\%$ RH of setpoint.
 - d. Chilled and system temperatures shall be maintained within $\pm 0.5^{\circ}\text{F}$ of setpoint.
 - e. Duct static pressures shall be maintained within $\pm 0.05"$ wg of setpoint.
 - f. Hydronic system pressures shall be maintained within ± 2 psig of setpoint.
 - g. Air and water quantities shall be maintained within $\pm 5\%$ of setpoint.
3. Final system acceptance will be based upon the completion of the following items:
 - a. Completion of the installation of hardware and software items. Demonstrate complete operation of the system, including hardware and software, with no failures during a 10 consecutive day period. Obtain receipt from the Owner acknowledging no failures within the test period. Submit a daily log documenting failures.
 - b. Satisfactory completion of functional performance testing.
 - c. Satisfactory completion of the record drawings, and operating and maintenance manuals.
 - d. Satisfactory completion of training programs.
4. Upon final acceptance, the warranty period shall begin.

I. BCS Training:

1. Provide the Commissioning Authority with a training plan for review 4 weeks before the planned training.
2. Provide designated Owner personnel training on the control system. The intent is to clearly and completely instruct the Owner on the capabilities of the control system.
3. The training shall be tailored to the needs and skill-level of the trainees.
4. The trainers shall be knowledgeable on the system and its use in buildings. The Owner shall approve the instructor prior to scheduling the training.
5. The standard operating manual for the system and any special training manuals shall be provided for each trainee, with a copy included in each copy of the operation and maintenance manual. In addition, copies of the system technical manual shall be demonstrated during training and a copy included in each copy of the operation and maintenance manuals. Manuals shall include detailed description of the subject matter for each session. The manuals shall cover control sequences and

- have a definitions section that fully describes relevant words used in the manuals and in software displays.
6. Copies of audio-visual materials used in the training program shall be delivered to the Owner.
 7. Provide formal training sessions. Each session shall be conducted by factory-trained personnel:
 - a. Training I: the first training session shall consist of 24 hours of actual training. This training may be held on-site or in the supplier's facility. If held off-site, the training may occur prior to final completion of the system installation. Provide materials and training for up to 6 persons to be designated by the Owner. Upon completion, each student, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.
 - b. Training II: Building Systems: the second session shall be held on-site for a period of 24 hours of actual hands-on training after the completion of system commissioning. Provide materials and training for up to 6 persons to be designated by the Owner. The session shall include instruction on:
 - 1) Specific hardware configuration of installed systems in this building and specific instruction for operating the installed system, including HVAC systems, lighting controls, and any interface with security and communication systems.
 - 2) Security levels, alarms, system start-up, shut-down, power outage, and restart routines, changing setpoints, and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and setpoints that if changed will adversely affect energy consumption, energy accounting, and procedures for obtaining vendor assistance.
 - 3) Trending and monitoring features (values, change of state, and totalization), including setting up, executing, downloading, viewing both tabular and graphically and printing trends. Trainees shall actually set-up trends in the presence of the trainer.
 - 4) Every screen shall be completely discussed, allowing time for questions.
 - 5) Use of keypad or plug-in laptop computer at the zone level.
 - 6) Use of remote access to the system via telephone lines or networks.
 - 7) Setting up and changing a terminal unit controller.
 - c. Training III: the third training session shall be conducted on-site 6 months after occupancy and consist of 24 hours of training. Provide materials and training for up to 6 persons to be designated by the Owner. The session shall be structured to address specific topics that trainees need to discuss and to answer questions concerning operation of the system.
 - d. Supervisory training: provide a separate training course for supervisory personnel. This training shall briefly cover the material of the operator training session but shall address the more advanced features of the system with emphasis on the energy conservation strategies and reporting capabilities of the system and how to implement them. The training session shall be conducted by factory-trained personnel and shall be a minimum of two 8 hour days, for a total of 16 training hours. Provide materials and training for up to 6 persons to be designated by the Owner.
 8. In addition to the specified BCS training, provide technically competent technicians to attend training sessions for systems and equipment that are monitored or otherwise interfaced with the BCS, to discuss the interaction of the control system to the equipment being discussed.
- J. Control System Operation and Maintenance Manual Requirements:
1. In addition to documentation specified elsewhere herein, compile and organize operation and maintenance manuals in labeled 3-ring binders. The manual shall be organized and subdivided with permanently labeled indexed tabs, containing at minimum:
 - a. Full as-built sequence of operations for each piece of equipment.

- b. Full as-built set of control drawings, including the marking of system components, sensors, and thermostats, and power sources on the as-built floor plans and mechanical drawings, identified with their control system designations.
- c. Full point list. In addition to the as-built points list for the major equipment identified in the I/O summary, provide a listing of rooms served by BCS terminal controls, with the following information for each room:
 - 1) Floor.
 - 2) Room number.
 - 3) Room name.
 - 4) Air handling unit identification.
 - 5) Reference drawing number.
 - 6) Terminal unit tag identification.
 - 7) Heating and/or cooling valve tag identification.
 - 8) Minimum cfm.
 - 9) Maximum cfm.
- d. Controller/module data shall include specific instructions on how to perform and apply functions, features, and modes specified herein and other features of this system. These instructions shall be step-by-step. Indexes and clear tables of contents shall be included. The detailed technical manual for programming and customizing control loops and algorithms shall be included.
- e. Control equipment component submittals and parts lists.
- f. Thermostats, sensors, switches, and timers, including maintenance instructions and sensor calibration requirements and methods by sensor type.
- g. Valves and valve actuators.
- h. Dampers and damper actuators.
- i. Full as-built documentation of software programming, including commented software program printouts, and a full print out of all schedules and setpoints after testing and acceptance of the system. Provide an electronic copy of programming and database information for this facility.
- j. Warranty requirements.

3.4 THERMOSTATS

- A. Mount space humidity sensors, humidistats, space CO₂ sensors, space temperature sensors, and thermostats at 48" above the floor.
 - 1. Align horizontally with adjacent light switches.
 - 2. Final locations shall be accessible and shall be coordinated with the furniture layout and architectural layout.
 - 3. More than 2 sensors in a single location shall be installed with a common faceplate to minimize wall space.
- B. Remote element type: mount on a vibration free surface 5' above the floor, unless specified herein to be mounted on a control panel. Provide 1 linear foot of element to sense the temperature of each ft² of the coil face. Install in a serpentine arrangement across the entire face of the coil.
- C. Averaging and low limit safety type elements: install in a horizontal sine curve manner to sense temperatures across the entire face of the coil, and support independently from the coil by stainless steel bands or multibulb holders. Provide 1 linear foot of element for each ft² of coil area. Provide 0.5" metallic raceway or 0.375" hard copper rails for support of elements, both top and bottom, for plenum or duct width greater than 36".
- D. Under window fan-coil unit thermostats: mount so that adjusting knob is accessible through access panel.

- E. Provide guards on thermostats and space temperature sensors in storage rooms and equipment rooms.
- F. Provide insulated bases for thermostats and temperature sensors installed on exterior walls or walls to unconditioned spaces.

3.5 PANELS

- A. Provide a panel for each BCS controller or each system not controlled by the BCS.
- B. Mount the following items in the panels unless otherwise specified herein:
 - 1. BCS controllers.
 - 2. Relays.
 - 3. Switches.
 - 4. 120 V duplex convenience outlet wired from the same circuit as the BCS controller.
 - 5. Wiring and controls.
 - 6. Terminal blocks.
 - 7. Gauges showing main pressure, and control pressure of each control or controlled device in the panel.
 - 8. Remote bulb thermostats and receiver controllers.
 - 9. Thermometers on panels showing outside, supply, and return air temperatures for air handling units.
 - 10. Thermometers on panels showing outside air, and entering and leaving water temperatures for hydronic systems.
- C. Wire controllers, relays, switches, and controls in the control panel to a terminal block. Line voltage and low voltage shall be separated on different terminal blocks with labels indicating voltage. Each sensor or other electrical device shall be wired back to the terminal block in the control panel. Devices in series shall be individually terminated at the terminal block, such that each side of each device is available at the control panel for troubleshooting. In addition to number markings on each conductor, conductor color shall be the same throughout each wiring run. Wiring shall be neatly tied and routed in the control panel. Shielded wiring shall be terminated neatly, with heat shrink tubing placed over the bare end of the shield. Ground conductors over 4" long shall be insulated with tubing.
- D. Provide 6" x 6" trough the width of the control panel, minimum 24" in length, above the control panel to provide an entrance for cabling and tubing into the panel, with 50% spare nipple capacity.
- E. Provide 120 V power wiring for control power in the top right corner of each panel, with disconnects, power supplies, and transformers associated with the panel also located in the top right corner.
- F. Each item in the panel shall be labeled and the panel labeled as to the system or equipment served.
- G. Panels shall be located to avoid conflicts with ductwork, piping, equipment, the work of other trades, and building conditions. Panel locations indicated on the Drawings shall be coordinated prior to installation and adjusted to avoid conflicts.

3.6 STATIC PRESSURE SENSORS

- A. Install sensors in the associated air handling unit control panel and use extended sensing lines. Provide taps for calibration purposes.

3.7 HYDRONIC PRESSURE SENSORS

- A. Install sensors adjacent to measurement points, with sensing lines extended to accessible locations. Provide test ports equipped with Schrader valves in each sensing line for calibration purposes.

3.8 THERMOMETERS

- A. Provide at each remote temperature sensor and element location. Do not duplicate thermometers specified in Section 231000, Piping, Valves and Accessories.
- B. Mount thermometers in piping, ducts, and equipment in positions adjusted to be accessible for reading. Use angle and adjustable types where straight type would not be readable.
- C. Fill thermometer wells with thermally conductive material.

3.9 CONTROL DAMPERS

- A. Refer to Section 237000, Air Distribution, for installation.
- B. For outdoor air damper assemblies, stage the opening of each section to prevent stratification and poor mixing of outside and return air.

3.10 SMOKE DETECTORS

- A. Refer to Section 237000, Air Distribution, for installation.

3.11 CONTROL VALVES

- A. Refer to Section 231000, Piping, Valves and Accessories, for installation.
- B. Provide high pressure air, if necessary, for valve actuators.

3.12 WIRING

- A. Materials and installation of wiring and electrical devices shall be in accordance with Division 26.
- B. Control and sensor wiring shall be installed in conduits and shall be separate from AC wiring of any voltage. Conduits to devices in finished spaces shall be concealed.
- C. Exposed control and sensor wiring shall be installed in conduits and shall be separate from power wiring. Plenum rated cable may be used in concealed spaces if run parallel to structural grid and supported by cable trays or tie wraps, and identified in a manner consistent with the documentation of the system every 30'. Conduits to devices in finished spaces shall be concealed.
- D. Provide transformers or filters for operation of automatic temperature controls from building power circuits. Each BCS controller shall be served by a dedicated transformer, and no more than 10 terminal unit controllers shall be served by a single transformer.
- E. Provide relays, transformers, fuses and interlock wiring as required to accomplish the sequences indicated on the Drawings.
- F. Wiring for emergency fan shutdown stations shall be separate from control and sensor wiring and devices.
- G. See Division 26 for 120 V, 20 A electrical branch circuits designated for control power, terminated in junction boxes. Provide power wiring from the designated junction boxes through control power transformers to BCS controllers, terminal unit controllers, smoke dampers, flow measuring devices, and other power consuming control devices.

- H. See Division 26 for spare branch circuit breakers for control power in 120 V/208 V electrical panel boards. Provide power wiring from electrical branch panelboards through control power transformers to BCS controllers, terminal unit controllers, smoke dampers, flow measuring devices, and other power consuming control devices.
- I. Provide data outlets and associated low voltage cabling for each NAC and BCS controller as required. See Division 27 for communications cabling and outlet requirements. Coordinate the installation of new data outlets with the Owner's Information Technology staff.
- J. Power for terminal unit controllers and smoke dampers shall be distributed at 24 V. For terminal units containing fans or electric heat, control power may be obtained from a control power transformer furnished with the terminal unit.
- K. Branch circuit wiring and conduit furnished under this Section for control equipment power shall be separate from other power wiring. No more than 2 BCS controller installations shall operate from a single 120 V branch circuit.
- L. Low voltage control and sensor wiring shall be continuous without splicing.

3.13 AIR PRESSURE GAUGES

- A. Install a gauge on each controlled device except room thermostats. Gauges may be mounted in or on the control panel if the controlled device is within sight from the panel.
- B. On positive positioning devices, provide gauges for both pilot input and actuator signals.

3.14 AIRFLOW MEASUREMENT SYSTEMS

- A. Install in straight duct sections, in accordance with manufacturer's recommendations and minimum straight duct length requirements.
- B. Manufacturer shall provide start-up services, and demonstration testing for the Owner to verify the accuracy of each system, and shall submit a certificate indicating same.

3.15 SEQUENCES

- A. As indicated on the Drawings.

END OF SECTION 238000

SECTION 260010 - ELECTRICAL GENERAL

PART 1 - GENERAL

1.1 DESCRIPTION

- A. These electrical general provisions specified herein apply to all Sections of Division 26.
- B. Refer to the General and Supplementary Conditions and Division 01 for special requirements and conditions which apply to all Sections of Division 26.
- C. This Section includes responsibilities and obligations in support of the performance verification specified in Section 260090, Electrical Performance Verification, and commissioning specified in Section _____.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. North Carolina State Electrical Code-2018.
 - 2. North Carolina State Energy Conservation Code-2018.
 - 3. NECA 1-2015.
 - 4. NECA 200-2016.
- B. Codes, standards and regulations specified herein refer to the edition date. Revisions and addenda to these codes, standards and regulations shall be part of these specifications. Provisions of referenced codes, standards and regulations do not create duty or responsibility by the Architect or the Owner, unless otherwise specified herein.
- C. Codes, standards and regulations referred to are minimum standards. Where the requirements of these specifications or drawings exceed those of the codes, standards and regulations, the drawings or specifications govern.
- D. Electrical Design Coordination:
 - 1. The power ratings of mechanical, plumbing, and fire suppression system motors and equipment and the characteristics of electrical systems serving them, as specified in other divisions, have been established as minimums which will allow that equipment to satisfactorily function while producing the capacities indicated on the Drawings or specified herein. These power ratings include a safety factor deemed appropriate to accommodate common differences between design parameters and field construction practices.
 - 2. Reasonable efforts have been made to coordinate the electrical requirements of the equipment specified in other divisions with the electrical systems serving that equipment. Differences among manufacturers of equipment make it impossible to produce a single electrical design which will satisfy the varying electrical requirements of those manufacturers. Consequently, the Contractor shall coordinate the electrical requirements of the equipment actually furnished on this Project and provide the electrical systems required by that equipment. This coordination effort shall be completed prior to the installation of either the equipment or the electrical systems serving that equipment. Electrical system revisions required to coordinate with the equipment actually furnished shall be provided at no additional cost to the Owner.
 - 3. Equipment specified in other divisions:
 - a. Audio-visual systems.
 - b. Automatic temperature controls.
 - c. Building control system.

- d. Communications systems.
- e. Elevators.
- f. Fire detection and alarm systems.
- g. Fire suppression systems.
- h. Fuel systems.
- i. Heating, ventilating and air conditioning systems.
- j. Laundry equipment.
- k. Modular furniture systems.
- l. Plumbing systems.
- m. Power-operated doors.
- n. Security systems.
- o. Sprinkler waterflow and valve monitor switches.
- p. Projection screens

1.3 SPACE CONDITIONS

- A. Drawings are diagrammatic in nature and, unless explicitly dimensioned, indicate appropriate locations of fixtures, apparatus, equipment and raceways. Changes in the location, and offsets, of same to accommodate building conditions and coordination with the work of other trades, shall be made during the preparation of coordination drawings and prior to initial installation, without additional cost to the Owner.
- B. Locations of motors, starters, equipment and apparatus as indicated on the Drawings are approximate; connections shall be made to such equipment as actually installed.
- C. Provide access to equipment and apparatus requiring operation, service or maintenance throughout the life of the system.
- D. Install switchboards and panelboards, such that no piping, ductwork or mechanical equipment is installed in the space equal to the width and depth of the equipment from floor to structure above. In addition switchboards, panelboards, variable frequency drives, transformers, and starters shall be installed such that the working space in front, rear and/or side (where rear and/or side access is required to work on equipment) is clear of piping, ductwork, or mechanical equipment. Dimensions of the working space shall be a minimum depth of 42" horizontally, the width of the equipment or 30", whichever is greater, and the height of the equipment or 78", whichever is greater. Minimum depth shall be increased to 60" for equipment rated over 600 V.
- E. Do not install pad-mounted transformers less than 15' from any doorway or building structure (exterior walls, walkways, overhangs, balcony or windows). Orient the transformer such that the access area is facing away from the building.

1.4 ENVIRONMENTAL AIR-HANDLING SPACES

- A. Electrical power conductors installed in environmental air-handling spaces shall be approved for installation in plenum areas.
- B. Communications, data, control, and signal cable not in conduit or enclosed wireways shall be approved for installation in plenum areas.
- C. Busway installed in spaces above or behind access panels used for environmental air shall be feeder type with no provisions for plug-in connections.

1.5 ASBESTOS MATERIALS

- A. Materials containing asbestos or any trace of asbestos related materials shall not be used on this Project.

1.6 DEFINITIONS

- A. Exposed raceways are those which can be seen when the base building is complete without opening or removing access doors or panels or accessible ceiling components.
- B. Other raceways are considered to be concealed.

1.7 RELATED WORK DESCRIBED IN OTHER DIVISIONS

- A. Cutting, coring, waterproofing, and patching of walls, floors, ceilings, roofs and structure of existing building.
- B. Installation of access panels in wall and ceiling construction.
- C. Painting, except as specified herein.

1.8 SUBMITTALS

- A. Within 5 days after notice to proceed, submit a schedule indicating the proposed submission date of each submittal specified herein. Schedule shall anticipate the submittal review time, the possible need for resubmittals, and the time required for fabrication, shipping and integration into the construction sequence. Architect will advise of any conflicts in reviewing submittals that the proposed schedule presents.
- B. Submittals shall be prepared in a line-by-line format corresponding to these Specifications and shall indicate compliance with each requirement specified herein and indicated in the Drawings.
 - 1. In addition to any other transmittal or cover sheet used, fill out and attach to each individual submittal a copy of the Cover Sheet for Submittals to Newcomb & Boyd included at the end of this Section.
 - 2. Indicate manufacturer's installation instructions.
 - 3. Indicate deviations, if any, including any from the manufacturer's installation instructions.
 - 4. Reproductions or electronic versions of design drawings shall not be used in the preparation of shop drawings.
 - 5. Resubmittals that are required to address review comments shall include a cover transmittal with a written explanation of how each review comment has been addressed.
 - 6. Submittals not specifically required, or not complying with the format requirements, will be returned unreviewed.
 - 7. Shop drawings and submittals shall be provided in portable document format (PDF). PDF files containing multiple drawings or components shall include an index of the file contents and electronic bookmarks.
- C. Electrical submittals shall include the following:
 - 1. Cable trays, including dimensional layout drawings showing support and hangers locations, floor opening requirements, elevations, switchboard adaptors, conduits, and boxes.
 - 2. Performance Verification Supervisor qualifications.
 - 3. Coordination drawings, with dimensions and elevations of electrical conduit 2" and larger, cable trays, busways, equipment, and recessed luminaires, coordinated with the work of other trades, including HVAC, plumbing, fire suppression, structural, and architectural, minimum 1/4" = 1'-0" scale.

4. Dry-type transformers.
5. Electrical equipment room drawings, with dimensions and elevations, for each riser closet and major electric and telephone/data room showing equipment, risers, and code required clearances, minimum 1/4" = 1'-0" scale. Drawings shall be submitted prior to or concurrent with distribution equipment submittals.
6. Emergency power supply system, including generator decrement curve and available fault current at the generator terminals.
7. Floor boxes.
8. Individual circuit breakers.
9. Lighting control devices.
10. Lightning protection system.
11. Low voltage busways.
12. Luminaires, including:
 - a. Data including specified options, photometrics, mounting or suspension devices, and associated details.
 - b. Emergency driver information including initial lumen output, input voltage, battery type, and test switch/indicator lamp arrangement.
13. Modular flexible wiring systems, including circuit diagrams.
14. Occupancy sensor layout and coverage drawings showing sensor locations and coverage patterns in spaces with lighting controlled by occupancy sensors. Drawings shall be minimum 1/8" = 1'-0" scale.
15. Overcurrent protective devices.
16. Panelboards.
17. Short circuit and overcurrent protective device coordination study.
18. Surge protective devices.
19. Switchboards, including equipment nameplate designations.
20. Time switches.
21. Uninterruptible power supply, including size, weight, and configuration, and equipment nameplate designations.
22. Vibration isolation.

1.9 EQUIPMENT AND INSTALLATION REQUIREMENTS

- A. Motor quantities, sizes and equipment wattage ratings specified in other divisions or indicated on the Drawings are the minimum requirements. Motor quantities, sizes and equipment wattage ratings less than those specified in other divisions or indicated on the Drawings are not acceptable. Larger motor sizes and equipment wattage ratings may be provided if necessary to meet the prescriptive requirements specified in those divisions. Where multiple motors or motor sizes or equipment wattage ratings larger than specified in those divisions or indicated on the Drawings are furnished, provide and coordinate the corresponding increased number or capacity of feeders and other electrical equipment serving them, at no additional cost to the Owner.
- B. Equipment and materials, except as otherwise specified herein, shall be new and shall be of the customary standard and quality furnished by the designated manufacturer for that catalogue number.
- C. Materials and equipment shall be UL listed, and shall bear the UL listing mark on products for which standards have been established and for which listing is regularly furnished by UL.

1.10 SHORT CIRCUIT AND OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

- A. Submit a short circuit and overcurrent protective device coordination study prepared in accordance with IEEE 242-2001 and IEEE 399-1997 by the switchboard manufacturer at the time of final submittal of the switchboard submittals. Studies shall be prepared under the supervision and approval of a licensed

professional electrical engineer skilled in performing and interpreting power system studies. Do not release the switchboard for construction until the study is submitted and approved.

1. The short circuit study shall show that electrical equipment including switchgear, switchboards, panelboards, motor control centers, busways, switches, and overcurrent protective devices in the electrical distribution system are applied within their short circuit and withstand current ratings.
 2. The short circuit and overcurrent protective device coordination study shall include:
 - a. Time current curves, with different color for each curve, plotted on full scale log-log graph paper for overcurrent devices, starting characteristics of motors, transformer full load current, magnetizing current and withstand parameter curves, cable damage curves, engine-generator set fault current and decrement curves, and motor starting characteristics and damage points. Curves for adjustable devices shall be shown adjusted to afford maximum coordination with upstream and downstream devices, including devices provided by the electric utility system, and minimize arc flash hazard levels.
 - b. Source impedance data, including electric utility system and motor fault contribution characteristics.
 - c. One-line diagram showing equipment designations, protective device ampere ratings and associated designations, cable size and lengths, transformer kVA and voltage ratings, motor and engine-generator set kVA ratings, available fault at each bus, bus withstand ratings, and device interrupting ratings, and arc flash protection boundary, incident energy, and PPE.
 3. For this study, assume an unlimited a maximum 100 500 _____ MVA fault current capacity is available from the utility primary system.
 4. For this study, assume a maximum _____ A fault current capacity is available from the utility transformer.
 5. The sources of fault current for the study shall include the utility's single-line-to-ground fault and three-phase bolted fault with X/R ratio for each fault component and fault current contributions from engine-generator sets.
 6. The interrupting capacity of overcurrent devices shall equal or exceed the maximum fault current level where they are installed in the system. Except as specified herein, the system shall be fully rated in that the ability of the device to interrupt a fault at its terminals shall not depend on the characteristics of an overcurrent device upstream.
 7. The branch circuit devices installed in panelboards having mains 225 A and smaller may be series rated with the main breaker in the panel, the breaker serving the panel, or the fuse serving the panel, provided that the device is 225 A or smaller.
 8. Where minimum interrupting capacities are indicated on the Drawings, the value is the minimum symmetrical AIC required. Where interrupting capacities are not indicated for a particular device, the interrupting capacity of the next device upstream shall be used.
 9. Where the short circuit study indicates a fault level different from that indicated on the Drawings, describe the variance and include back-up information and calculations.
 10. A schedule of adjustable devices indicating proper dial and tap settings to achieve the plotted characteristics shall be submitted with the study.
 11. Short circuit and overcurrent protective device coordination study shall be submitted in the form of 1 set of original reproducible, 3 copies thereof, and an electronic copy in PDF format.
- B. Submit concurrently with the overcurrent protective device coordination study an arc flash evaluation study prepared in accordance with NFPA 70E-2018 and IEEE 1584-2018, by the switchboard manufacturer. The study shall determine the flash protection boundary and personal protective equipment required for personnel within the flash protection boundary and shall include the creation of arc flash hazard warning labels. The study results shall be summarized in a final report and included with the short circuit and overcurrent protective device coordination study. Do not energize electrical equipment until the study is submitted and approved and the arc flash labels are affixed on the equipment.
1. The flash protection boundary and the incident energy shall be calculated at significant locations in the electrical distribution system (switchboards, switchgear, motor control centers, panelboards, busway and splitters) where work could be performed on energized parts.

2. Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm².
3. Arc flash calculations shall include:
 - a. Arcing fault magnitude.
 - b. Device clearing time.
 - c. Duration of arc.
 - d. Arc flash boundary.
 - e. Working distance.
 - f. Incident energy.
 - g. Hazard risk category.
4. Arc flash labels shall have an orange header with the wording "WARNING, ARC FLASH HAZARD" and shall include the following information:
 - a. Location designation.
 - b. Nominal voltage.
 - c. Flash protection boundary.
 - d. Hazard risk category.
 - e. Incident energy.
 - f. Working distance.
 - g. Required level of personal protective equipment.
 - h. Engineering report number, revision number and issue date.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATION

- A. Apparatus shall be by one manufacturer, except where specified herein otherwise.
- B. Isolators shall conform to the following:
 1. Type DN - Double-deflection neoprene type, with neoprene-coated metal surfaces, and top and bottom surfaces ribbed. Isolators shall have bolt holes in the base.
 - a. Manufacturer: Kinetics Noise Control RD, Mason ND, Vibration Eliminator T44 or D44, VMC Group R or RVD, or Vibro-Acoustics RD.
 2. Type NH - Double-deflection neoprene or natural rubber hanger type, with neoprene or natural rubber grommet between hanger rod and housing. Neoprene or natural rubber element shall have neoprene- or natural rubber-coated metal surfaces.
 - a. Manufacturer: Kinetics Noise Control RH, Mason HD, Vibration Eliminator C, VMC Group HR, or Vibro-Acoustics NH.

2.2 SEISMIC AND WIND RESTRAINTS

- A. Seismic force design shall be determined in accordance with the following seismic design criteria:
 1. Office Tower
 2. Seismic Design Category: C
 3. Risk Category: II.
 4. Component Importance Factor, I_p: 1.0.
 5. E.O.C. Building
 6. Seismic Design Category: D.
 7. Risk Category: IV.
 8. Component Importance Factor, I_p: 1.5.

- B. Provide restraint devices as required for vibration isolated and nonvibration isolated electrical components. Provide calculations to determine restraint loadings for specific equipment to be installed resulting from seismic forces on equipment. Seismic restraint calculations shall be signed by a licensed engineer in the employ of the seismic restraint device manufacturer.
- C. For roof-mounted equipment and components both the seismic acceleration and wind loads shall be calculated, and the highest load shall be utilized for the design of the seismic restraints and vibration isolators.
- D. Exceptions for electrical components listed within the applicable project building code may be utilized. However, use of exceptions shall be noted with submitted seismic restraint calculations.
- E. Seismic restraints and vibration isolators provided with integral seismic restraint capacity shall have Anchorage Preapproval "R" Number from OSHPD in the State of California listing minimum certified horizontal and vertical load ratings.
- F. Provide restraint devices as necessary for luminaires in suspended ceiling systems as required by ASTM E580/E580M-2017.
- G. Floor-Mounted Restraints:
 - 1. All-directional external seismic restraints for floor-mounted components shall consist of interlocking steel assemblies restrained when engaged under seismic motion by elastomeric material with a minimum thickness of 0.25". The minimum air gap between interlocking assemblies shall be 0.125".
 - 2. Restraints for neoprene vibration isolators shall consist of Type DN isolators with the addition of welded steel housings to resist seismic forces.
 - 3. Restraints for free-standing floor springs shall consist of Type FS isolators with the addition of welded steel housings to resist seismic forces. Restraints shall allow a maximum movement of 0.25" in all directions.
 - 4. Manufacturer: Kinetics Noise Control, Mason, VMC Group, Vibration Eliminator, or Vibro-Acoustics.
- H. Suspended Restraints:
 - 1. Restraints for vibration isolated suspended equipment, conduit, and raceways shall consist of galvanized or stainless steel aircraft cables with end connection fittings designed to swivel in order to ensure proper cable alignment and avoid bending of cable.
 - 2. Restraints for nonvibration isolated suspended equipment, conduit, and raceways shall consist of steel angle or unistrut with anchor bolts and end connection fittings designed to swivel to the final installation angle.
 - 3. Manufacturer: B-Line, International Seismic Application Technology, Kinetics Noise Control, Mason, Tolco, VMC Group, Vibration Eliminator, or Vibro-Acoustics.

2.3 CONCRETE

- A. Normal weight concrete (145 pcf) using Type I Portland Cement, 1" maximum size coarse aggregate to provide a minimum 28 day compressive strength of 3000 psig.

2.4 GROUT

- A. Nonshrink type, conforming to ASTM C1107/C1107M-2017 when tested at fluid consistency. Grout shall exhibit zero bleeding at every age when mixed to fluid consistency. Minimum 28 day compressive strength, when mixed to fluid consistency, shall be 7000 psig.

- B. Manufacturer: Cormix, or Master Builders.

2.5 ACCESS PANELS - BUILDING

- A. Refer to Section 083113, Access Panels.

2.6 SLEEVES

- A. Wall sleeves shall be galvanized rigid metal conduit or electrical metallic tubing.
- B. For floor slabs above grade, plastic core form block-outs shall be used.

2.7 PENETRATION SEALS

- A. Firestops:
 - 1. Refer to Section 078443, Joint Firestopping.
- B. Seal Assemblies:
 - 1. Seal assemblies shall consist of a frame, compression mechanism, and insert modules. Assemblies shall be waterproof and shall be designed to allow easy addition or deletion of penetrating items.

2.8 NETWORK CABLES, CONNECTORS AND EQUIPMENT

- A. General:
 - 1. Cable construction, insulation, and jacket shall comply with the requirements for the application for which it is used. Provide type CM or CMG for general use; type CMP for plenum use; and CMR for riser use.
 - 2. Cables and conductors installed in enclosures or raceways underground or in slabs on grade shall be UL listed for use in wet locations.
 - 3. Electrical wire and cable shall have lead content less than 300 parts per million.
- B. RS-232 Cables:
 - 1. Two twisted pairs, #22 AWG, stranded (7x30) tinned-copper conductors, each pair individually shielded with aluminum foil-polyester tape to provide 100% shield coverage.
 - 2. Pairs shall be cabled on common axis with #24 AWG, stranded (7x32) tinned-copper drain wire.
 - 3. Flame resistance: nonplenum-rated cable shall comply with UL 1581-2001 (R2017). Plenum-rated cable shall comply with NFPA 262-2019.
- C. RS-485 Cables:
 - 1. Two unshielded twisted pairs, #22 AWG, stranded (7x30) tinned-copper conductors.
 - 2. Flame resistance: nonplenum-rated cable shall comply with UL 1581-2001(R2017). Plenum-rated cable shall comply with NFPA 262-2019.
- D. Control Cables:
 - 1. Multiconductor, color-coded type, #22 AWG or larger conductors (sized for voltage drop), stranded tinned-copper for energy limited control circuits. Multiconductor, color-coded type, #14 AWG or larger conductors (sized for voltage drop), stranded tinned-copper for other control circuits.
 - 2. Flame resistance: nonplenum-rated cable shall comply with UL 1581-2001(R2017). Plenum-rated cable shall comply with NFPA 262-2019.

- E. Network Cables:
1. UL listed and CSA certified.
 2. Category 5e cables shall meet TIA/EIA 568.1D-2015 Addendum 2018 requirements for category 5e cable.
 3. Additional Cable Performance Requirements:
 - a. Minimum power sum ACR: 9 dB at 155 MHz.
 - b. Maximum attenuation: 21 dB at 100 MHz per 100 m.
 - c. Minimum power sum near end crosstalk: 36 dB at 100 MHz.
- F. Surge Protective Devices (SPDs):
1. This SPD specification applies to low voltage signal or communications cabling only. See Section 266710, Surge Protective Devices for other SPD applications.
 2. SPDs shall incorporate silicon avalanche technology, shall operate bidirectionally, and have a turn-on and turn-off time of less than 5 nanoseconds. Additional minimum requirements include:
 - a. Communication or Signal Conductor Transient Suppressors:
 - 1) SPDs shall be UL listed in accordance with UL 497B-2004.
 - 2) Maximum single impulse current conductor-to-conductor or conductor-to-ground: 10000 A, 8 x 20 μ s waveform, or 200 A, 10 x 1000 μ s waveform.
 - 3) Pulse life rating: 3000 A, 8 x 20 μ s waveform, 2000 occurrences, or 50 A, 10 x 1000 μ s waveform, 200 occurrences.
 - 4) Maximum clamping voltage at 100 A, 10 x 1000 μ s waveform, with the peak current not to exceed the normal applied voltage by 150%, except for coaxial cable suppressors with peak current, the maximum clamping voltage shall not exceed the normal applied voltage by 200%.
 - 5) Failure mode: fail short.
 - b. Manufacturer: Advanced Protection Technologies, Ditek, Emerson, Lightning Eliminators & Consultants, or Transtector.

2.9 UNDERGROUND WARNING TAPE

- A. Tape shall be acid and alkali resistant polyethylene film tape, 6" wide with minimum thickness of 0.004", specifically designed for marking and locating of underground utilities.
- B. Tape shall be manufactured with integral wires, foil backing or other means to enable detection by metal detectors when the tape is buried up to 18" deep. The metallic core of the tape shall be encased in a protective jacket or provided with other means to protect it from corrosion.
- C. Tape color shall be as specified below and shall bear a continuous printed inscription describing the specific utility:

<u>Utility</u>	<u>Color</u>
Electric	Red
Telephone/Data	Orange
Television	Orange
Security	Orange
Fire Communications	Orange

- D. Manufacturer: Carlton Industries, Empire Level, Seton, or Stranco.

2.10 IDENTIFICATION MATERIALS

- A. Emergency system markers: self-adhesive vinyl or plastic-coated cloth tape, approximately 1.5" x 2.5" with red background, printed as follows: "Contains Emergency Circuits - Do Not Install Conductors Within This Enclosure That Are Not Part of the Emergency System - Reconnect and Reenergize All Emergency Circuits As Soon As Possible."
- B. Tags: preprinted or partially preprinted accident prevention and operational tags, on plasticized card stock with matte finish for writing, approximately 3.25" x 5.625", with brass grommets and wire fasteners, and appropriate wording.
- C. Signs: 14" x 10" size, 0.04" thick aluminum base with baked enamel finish for indoor or outdoor use.
- D. Nameplates and Labels:
 - 1. White core plastic laminate with engraved lettering.
 - 2. Nameplate background color shall be black for normal power equipment and red for emergency power equipment.
 - 3. Nameplates for individual devices shall have 0.25" high letters.
 - 4. Nameplates for panelboards, switchboards, motor control centers, circuit and motor disconnects, dry-type transformers, and equipment shall have 0.5" high letters.
 - 5. Labels shall have minimum 0.25" high letters.

2.11 MISCELLANEOUS

- A. Diagram framing system: 0.125" thick acrylic with satin finish aluminum frames.

2.12 PAINTING

- A. Paint for high temperature equipment shall be high temperature resistant, designed for the temperatures at which the equipment will operate.

PART 3 - EXECUTION

3.1 PROTECTION OF EQUIPMENT AND MATERIALS DURING CONSTRUCTION

- A. Provide protective covers, skids, plugs or caps to protect equipment and materials from damage or deterioration during construction.
- B. Store equipment and material under cover, and off the ground or floors exposed to rain.
- C. For outdoor storage, protective covers of 10 mil thick black sheet plastic shall be fitted over equipment and materials. Covers shall be reinforced to withstand wind and precipitation. Set equipment and material on skids or platforms of height to avoid damage or deterioration from spattering and ground water.
- D. Provide dust and debris protection for motors, fixtures, and equipment operated during construction.

3.2 EQUIPMENT AND INSTALLATION REQUIREMENTS

- A. Cut and repair walls, floors and ceilings for the installation of the electrical work.
- B. Exterior building walls below grade shall not be pierced by hanger bolts.

- C. Except where specific instructions are included herein, install and connect equipment in accordance with the manufacturers' instructions and recommendations.
- D. Refer to manufacturer's or equipment supplier's shop drawings for exact type, number, location, dimensions and size of connections to equipment, including but not limited to:
 - 1. Fire protection equipment.
 - 2. Laundry equipment.
 - 3. Heating, ventilating, and air conditioning equipment, including power supplies to automatic temperature control systems.
 - 4. Plumbing equipment.
 - 5. Vertical transportation equipment.
- E. Provide final connections to electrically powered equipment provided under this and other Divisions of these specifications and by the Owner.
- F. In unfinished areas designated for future build out, install conduit and equipment tight against the structure to maximize the future ceiling height.
- G. Maintain physical separation between ferrous wiring methods, such as raceways, metal clad cable, armored cable, or outlet boxes, with piping for other systems. Where contact is unavoidable, provide separation with listed insulating material.
- H. Maintain minimum clearance of 12" between conduits and hot surfaces. This includes, but is not limited to:
 - 1. Heaters.
 - 2. Hot water piping.
 - 3. Flues.
- I. Coordinate the location of electrical equipment in elevator machine rooms with the approved elevator machine room shop drawings.

3.3 SHORT CIRCUIT AND OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

- A. Obtain information required for the study from the utility company and the equipment manufacturers.
- B. Protective devices shall be set and calibrated as recommended by the final approved fault current and coordination study.
- C. Apply arc flash hazard labels to equipment.

3.4 VIBRATION ISOLATION

- A. General:
 - 1. Select and locate vibration isolation equipment to give uniform loading and deflection, according to weight distribution of equipment.
 - 2. Vibration isolators shall be installed and connected, as specified herein, or as indicated on the Drawings, in accordance with the manufacturer's written instruction and certified submittal data.
- B. Equipment Isolation:
 - 1. Engine-generator sets not tank-mounted shall be mounted on Type FS isolators with a minimum static deflections of 1" 2".

2. Floor-mounted transformers shall be mounted on Type DN isolators with a minimum static deflection of 0.1".
3. Suspended transformers shall be supported with Type NH isolators with a minimum static deflection of 0.1".
4. Type AS isolators shall be connected to the building control air supply system. Threads cut into compressed air galvanized pipe shall be painted with zinc-rich paint.
5. Threads on compressed air fittings and bolts shall be fully engaged. Threads shall be made up using joint compound or Teflon tape.
6. Mount air compressor on Type NS isolators with a minimum static deflection of 2".

3.5 SEISMIC AND WIND RESTRAINTS

- A. Restraints shall be installed after the equipment is mounted, connected, and operating to ensure that no contact occurs during normal equipment operation.
- B. Installation of seismic restraints shall not cause any change of position of equipment, conduit, or raceways, resulting in stress and misalignment.
- C. No rigid connections between equipment, conduit, or raceways and the building structure shall be made that degrade the vibration isolated system specified herein.
- D. Equipment that is internally vibration isolated and restrained shall have its entire unit assembly seismically attached to the structure.
- E. Do not brace a system to two different structures, such as a wall and a ceiling.
- F. Luminaires in suspended ceilings shall have cable restraints as required.
- G. After installation, manufacturer shall verify that seismic and wind restraints are installed and operating properly, and shall submit a certificate so stating.

3.6 FOUNDATIONS

- A. Provide concrete foundations for floor-mounted or grade-mounted switchboards, transformers, engine-generator sets, uninterruptible power supplies, and other similar equipment.
 1. Exterior foundations: minimum 8" thick pad, minimum 4" above surrounding grade with the exception of engine-generator sets which shall be a minimum of 6" above surrounding grade.
- B. Foundations shall be continuous and shall have beveled edges and smooth float finish. Foundations shall be reinforced with No. 3 bars a maximum of 12" on center each way, and held in place with dowel rods at each corner anchored in the slab. Dowel rods shall not penetrate the slab waterproofing.
- C. Roughen and clean exposed slabs before pouring foundations. Apply bonding agent to surfaces in contact.
- D. Foundations shall extend beyond the equipment footprint in each direction, including appurtenances, vibration isolators, and motors as follows: exterior - 6"; interior - 1", but not less than 1.5 times the seismic anchor embedment depth from the point of anchoring.
- E. Exterior foundations shall be supported on natural ground with organic material under pad removed. The subgrade shall be compacted to 90% modified proctor maximum dry density, ASTM D1557-2012e1, to a depth of 12". If the compaction density cannot be achieved with the existing soil, the existing subgrade shall be removed to a depth of 12" and replaced with clean backfill and compacted as specified above. A 4" thick granular subbase of sandy gravel or crushed stone shall be compacted with vibratory compactors.

Dampen the subbase prior to concrete placement. At the time of placement, the subbase shall not contain standing water.

- F. Fill voids between baseplates and foundations, and level equipment, with grout.

3.7 ACCESS PANELS - BUILDING

- A. Where electrical work is concealed by walls or ceilings, or is inaccessible, provide an access panel to provide access for service and maintenance.
- B. Electrical work located above ceilings is considered accessible if the ceiling is the accessible type and is arranged for access to the equipment.
- C. Fire rated access panels shall be provided in fire barriers, with ratings to match the construction fire rating.
- D. Access doors providing access to equipment access doors shall allow for service and maintenance of the intended equipment.
- E. Installation of access panels is specified under another Division.

3.8 SLEEVES

- A. Provide where conduits pass through elevated floor slabs if conduits are not a part of the slab pour, and for future cable or conduit risers.
 - 1. Install in raised foundations at least 2" high in electrical and mechanical rooms.
- B. Provide where communications and other cables, not installed in conduits, pass through walls and elevated floor slabs.
- C. Wall sleeves shall extend 4" from each side of the wall.
- D. Openings through slabs for busway risers shall be finished with a 4" wide x 2" high curb around the opening.
- E. Sleeves shall be secured in place. Provide insulating bushings on both sides of sleeves for cables.
- F. Provide ground bushings on both sides of sleeves containing ground conductors.

3.9 PENETRATION SEALS

- A. General:
 - 1. Install in accordance with the manufacturer's published instructions to achieve ratings and classifications specified herein. A copy of these instructions shall be maintained and available on site.
- B. Firestops:
 - 1. Close and firestop abandoned penetrations and penetrations through fire- and smoke-rated construction. Materials used to seal these penetrations shall continue the construction's fire and smoke resistance ratings uninterrupted and shall maintain an effective barrier against the spread of flame, smoke, water and hot gases.
 - 2. Install after installation of raceways and cable trays.

C. Expansion Seals:

1. Install to seal single conduit or cable penetrations of walls below grade.

D. Seal Assemblies:

1. Install to seal the penetration of walls below grade by multiple cables in the same opening.

3.10 NETWORK CABLES, CONNECTORS AND EQUIPMENT

A. General:

1. Make joints and connections with 60/40 resin-core solder or mechanical connectors. Temperature controlled soldering irons rated at least 60 W shall be used for soldering work.
2. Terminal blocks, boards, strips, and connectors shall be provided for cables which interface with racks, cabinets, consoles, enclosures, and equipment modules.
3. No cable shall be installed with a bend radius less than that recommended by the cable manufacturer.
4. Unused cables shall be dressed at each end in heat-shrink tubing and marked as unused.
5. Heat-shrink tubing shall be used to insulate and dress the ends of outdoor wires and cables, including a separate tube for the ground or drain wire.
6. No cables shall be wired with a polarity reversal between connectors, at either end. Special care shall be taken when wiring to ensure that constant polarity is maintained.

B. Network Cables:

1. Network cables shall be installed from each power monitoring device to the network outlet located adjacent to the equipment. The total length of this cable and the cable serving the outlet shall not exceed 295'.
2. Observe the bending radius and pulling strength requirements of the cables during handling and installation. Each run of cable between the power monitoring device and the network outlet serving the equipment shall be continuous without joints or splices.
3. Cables shall be routed at least 2' from fluorescent ballasts and at least 40" from electric motors or other high level sources of EMI.
4. Cabling routed above ceilings shall be in conduit.
5. Provide temporary protection of cables before termination. Cables shall not be left lying on the floor. Bundle and use cable ties to provide protection.
6. Provide clutch or shear pin protection for cables during cable pulling to ensure cable pulling tension is not exceeded.
7. Jacks shall be wired per the pair assignments indicated in the TIA/EIA 568.1D-2015 Addendum 2018 designation T568A or T568B wiring plan. Coordinate wiring to match communications outlets.
8. Network cables shall be installed and terminated in accordance with the manufacturer's recommended procedures.

C. Connectors:

1. Provide strain relief on connectors.
2. Provide blank coverplates for boxes intended for future use, unless otherwise indicated on the Drawings.
3. Insulate cables from receptacle faceplates.

D. Surge Protective Devices:

1. Install on low voltage signal or communications conductors entering the building from exterior locations, including those conductors from devices mounted on the exterior of the building.

3.11 PAINTING

- A. Except where otherwise specified herein, painting shall be done under another Division. Surfaces shall be left clean and free from oil.
- B. Equipment factory finishes damaged or deteriorated during construction shall be repaired to match original finish.
- C. Where galvanizing is broken during fabrication or installation, recoat exposed areas with zinc-rich paint.
- D. Exterior ferrous equipment and supports shall be painted 2 coats of rust preventive paint, color selected by the Architect.
- E. Exposed interior ferrous equipment, and exposed nongalvanized ferrous accessories and metal shall be prepared and painted 1 coat of corrosion resisting paint prior to other painting or identification, or 2 coats of corrosion resisting paints if no other painting is specified herein.

3.12 EXCAVATION AND BACKFILLING

- A. Determine exact location of existing underground utilities before excavation.
- B. Excavation shall be no longer or deeper than necessary. Backfill material shall be free from rocks and debris.
- C. Compact backfill as the excavation is filled.
- D. Excavation, shoring, bracing, backfilling, and compaction, cutting and patching of hardscape, and restoration of landscape shall conform to Division 31, Earthwork.

3.13 COORDINATION

- A. Provide offsets, transitions, and fittings to coordinate the work of each trade with that of other trades, including HVAC, plumbing, fire suppression, structural, and architectural.

3.14 UNDERGROUND WARNING TAPE

- A. During backfilling, install tape continuously at 4" to 6" below finished grade, above buried power, communications, or signal cables, conduits, and duct lines.
- B. Install multiple markers where cables are installed in groups exceeding 18" width.

3.15 CLEANING

- A. Luminaires:
 - 1. Remove dirt, dust, and grease, and polish reflector and trim surfaces, and clean lamps.
- B. Equipment and Equipment Rooms:
 - 1. Remove dust, dirt, rust, stains, and temporary covers.
 - 2. Foreign matter shall be blown, vacuumed, flushed, or cleaned out of and from equipment, luminaires, raceways, devices, switches, controls and panelboards.
 - 3. Clean and polish identification plates.

4. In equipment rooms, clean equipment, conduit, and room surfaces from dust and dirt and maintain in a clean condition from date of substantial completion until final completion of work and corrective work.
5. Remove excess material from the project site.

3.16 IDENTIFICATION

A. General:

1. Identification shall consist of upper case letters.
2. Where identification is applied to surfaces which require a finish, identification shall be installed after surface has been finished.

B. Box Color-Coding:

1. Paint connectors, couplings, bushings, hubs, entire conduit within 6" of a box, and panelboard backboxes for the different systems as listed below:

<u>System</u>	<u>Color</u>
System Emergency Power	Silver (unpainted with label)
System Normal Power	Silver (unpainted)
Fire Alarm	Red
Telephone	White
Data	Yellow
Sound System	Blue
Video Surveillance	Yellow

- C. Emergency system markers: install markers on boxes and enclosures, including transfer switches, engine-generator sets, and panels for emergency circuits. In addition, identify in indelible marker, emergency branch circuit panel and circuit numbers for branch circuits contained within each outlet box, on the cover of each box.

- D. Cable identification: install cable identification on each communication or signal cable.

E. Warning Signs:

1. Switchboards, panelboards, control panels, and motor control centers: install a warning sign on equipment enclosure in clear view which states, "Warning – Arc Flash and Shock Hazard – Appropriate Personal Protective Equipment Required." Signs shall be 5" wide by 3.5" high or larger.

- F. Danger signs: install in areas constituting a danger for persons in or about the Project.

G. Nameplates and Labels:

1. Install engraved nameplates at or on each circuit breaker, circuit and motor disconnect, motor controller, panelboard, switchboard, UPS system, lighting control panel, dry-type transformers, special apparatus, and communications and signal system, unless equipment is specified herein with its own self-explanatory identification. Text shall match terminology and numbering of the construction documents and submittals as close as practicable, and shall indicate equipment controlled as well as upstream distribution device and branch circuit or feeder designation.
2. Nameplates shall not cause interference with operation and maintenance of equipment. Attach nameplates with rustproof screws.

- H. Wiring devices: refer to Section 261430, Wiring Devices, for emergency marking and labeling requirements.

- I. Panelboards: install type written directories describing the load served by each circuit. Identify spaces and spares in pencil. Install on back of panelboard doors.
- J. Provide a sign at the normal service switchboard, and emergency power supply system switchboard, and fire pump service disconnect switch indicating other services and feeders supplying the building and the location of each.
- K. Provide a sign at the normal service switchboard indicating the type and locations of the on-site emergency power source.
- L. Provide a sign at the service switchboard indicating the maximum available fault current. The sign shall indicate the date the fault-current calculation was performed.
- M. Label each ground connection at the main grounding bus location to identify emergency and normal sources connected at that location.

3.17 OPERATION AND MAINTENANCE DOCUMENTATION PACKAGE

- A. These operation and maintenance manual requirements supplement operation and maintenance manual documentation requirements of other Sections of these specifications.
- B. Operation and maintenance documentation, in hardback 3-ring loose-leaf binders except full size drawings and CDs, shall cover the electrical systems. Documentation shall include the following: operations and maintenance documentation directory; emergency information; operating manual; maintenance manual; test reports; and construction documents.
- C. The operation and maintenance documentation package shall be submitted as one comprehensive package to the Owner 3 months before systems start-up, and shall be updated, revised and completed at completion of construction.
- D. Documentation shall be typewritten and shall contain, at a minimum, the following information.
 - 1. Introduction:
 - a. Project name, contractors' and subcontractors' names, addresses, and telephone and facsimile numbers. Indicate the portion of work for which each subcontractor was responsible.
 - b. Index.
 - 2. Operations and Maintenance Documentation Directory:
 - a. Explanation of the identification system used, including lists of systems, equipment and component identifiers and names.
 - 3. Emergency Information:
 - a. Information for technical and nontechnical personnel about actions recommended during emergency situations to protect life and property and to minimize disruption to the building occupants. Emergencies shall, at a minimum, include:
 - 1) Fire.
 - 2) Security breach.
 - 3) Power failure.
 - 4) Emergency power system failure.
 - 4. Operating Manual:
 - a. General Information:
 - 1) Building function.

- 2) Building description.
 - 3) Operating standards and logs.
 - b. Technical Information:
 - 1) System description.
 - 2) Operating routines and procedures.
 - 3) Routine operational testing program and procedures.
 - 4) Special procedures.
 - 5) Basic troubleshooting.
 - 5. Maintenance Manual:
 - a. Descriptions (specifications) of the equipment and components.
 - b. Description of function, as applicable: the function of the equipment, procedures before start-up, functional parameters (input, output) at the design load and at part loads, and performance verification procedures.
 - c. Recommended maintenance procedures and their recommended frequency for this Project.
 - d. Name, address and contact of at least one qualified service company.
 - e. Recommended list of spare parts, part numbers, and the place(s) from which they can be obtained.
 - f. Original purchase order number; date of purchase; name, address, and the telephone number of the vendor; and warranty information.
 - g. Installation information.
 - h. Any other information needed for the preparation of documents supporting the management of operation and maintenance programs.
 - 6. Test Reports and Certifications:
 - a. Copies of tests and certifications performed during manufacture and construction including, but not limited to, the following:
 - 1) Overcurrent protective device coordination study.
 - 2) Engine-generator set factory test report.
 - 3) Engine-generator set oil sample analysis.
 - 4) Selective catalytic reduction system control panel and dosing panel factory test report.
 - 5) Selective catalytic reduction system on-site acceptance test report.
 - 6) Lightning protection inspection certificate.
 - 7) Dry-type transformer test reports.
 - 8) Receipt for spare fuses.
 - 9) UPS certification, factory, and start-up test reports.
 - 10) Receipt of O&M documentation package.
 - 11) Receipt for instruction of operating personnel.
 - 12) Emergency power supply system on-site test report.
 - 13) Switchboard test reports.
 - 14) Ground resistance test.
 - 7. Construction Documents:
 - a. Record drawings.
 - b. Approved submittals, including revised shop drawings indicating field and as-installed conditions.
 - c. Equipment identification charts and schedules.
 - d. Warranty certificates.
 - e. Inspection certificates.
 - f. Performance verification report.
- E. Submit a receipt signed by the Owner acknowledging receipt of the operation and maintenance documentation package.

3.18 DIAGRAMS

- A. Frame and mount the following information:

<u>Information</u>	<u>Location</u>
One-line diagrams of the building electrical system.	Adjacent to each switchboard.
Overcurrent protective device schedule.	On the wall in the Main Electrical Room.
	Adjacent to water detection system control unit.

- B. Diagrams shall be type written or computer generated.
- C. Diagrams shall be as-built, and shall include interfaces and interlocks with other equipment.

3.19 RECORD DRAWINGS

- A. Refer to Section 017839, Project Record Documents.

3.20 MAINTENANCE

- A. Equipment operated prior to the date of the substantial completion shall be maintained in accordance with manufacturers' recommendations.

3.21 INSTRUCTION OF OPERATING PERSONNEL

- A. Conduct formal instruction sessions for operating personnel. Conduct two similar sessions. The first session shall be conducted at the time of start-up and check-out, and the second session shall be approximately 2 months later. Sessions shall be a minimum of 2 days duration for basic electrical systems, and as specified herein for other systems and equipment. Sessions shall be conducted at the site.
- B. Prepare and submit a syllabus describing an overview of the program, describing how the program will be conducted, when and where meetings are to be held, names and company affiliations of lecturers, description of contents and outline for each lecture, and recommended reference material and outside reading. Obtain direction from the Owner on which operating personnel shall be instructed in each system. Proposed training schedules, materials, and lesson plans shall be submitted to the Owner for review.
- C. Sessions shall include:
1. General familiarization and operating procedures for the entire electrical installation.
 2. Routine maintenance procedures for equipment.
 3. Specific operating and maintenance procedures for:
 - a. Switchboards.
- D. Factory-trained technicians shall give operating and maintenance instructions on the following systems and equipment:

<u>System/Equipment</u>	<u>Minimum Session Duration, hours</u>
Emergency power supply system	8

<u>System/Equipment</u>	<u>Minimum Session Duration, hours</u>
Modular flexible wiring systems	2
Occupancy sensors	2
Switchboards	4
Uninterruptible power supply system	8

- E. Provide DVD format video recordings of training sessions and a complete record copy of all training materials, handouts, and other printed materials used in each training session.
- F. Training shall occur after testing is complete, unless approved otherwise by the Architect.
- G. Obtain receipt acknowledging completion of each item of instruction.

END OF SECTION 260010

COVER SHEET FOR
SUBMITTALS TO NEWCOMB & BOYD

Project: _____ Date: _____

Item: _____ Submittal Number: _____

Manufacturer: _____ Model: _____

Specification Paragraph and/or Drawing Number: _____

Capacity: _____

Electrical Characteristics (including identification of all separate connections or services required): _____

Accessories: _____

Options: _____

Deviations (if any; if none, state so): _____

General Contractor Approval: _____

SECTION 260090 - ELECTRICAL PERFORMANCE VERIFICATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other electrical systems are specified in other Sections of Division 26.
- B. Performance verification is an ongoing process and shall be performed throughout construction. Performance verification verifies that systems are operating in a manner consistent with the Construction Documents.
- C. This Section covers electrical systems performance verification, as required to demonstrate that the equipment and systems of Division 26 are ready for safe and satisfactory operation, as defined by the Construction Documents. Performance verification shall include, but shall not be limited to, identification of equipment, cleaning, lubrication, start-up, check-out, testing and adjusting of systems, preparation of equipment and systems documentation and of maintenance and operation manuals, Owner training, and preparation of record drawings.
- D. The general requirements of the commissioning process and the duties of the Commissioning Authority are detailed in Section 290010, Commissioning. Become familiar with the requirements and coordination obligation of Section 290010, Commissioning and the commissioning schedule issued by the Commissioning Authority as they apply to the work of Division 26, and execute the performance verification responsibilities within the commissioning process as specified therein.
- E. Performance verification shall conclude with the completion of required deferred testing, training, and system documentation as specified herein and required to demonstrate the proper operation of the electrical equipment and systems provided by this Division.
- F. Verify, at a minimum, the performance of the following systems and equipment:
 - 1. Section 261150, Underground Ducts, Manholes and Handholes.
 - 2. Section 261200, Building Wire and Cable, 600 Volt.
 - 3. Section 261260, Modular Flexible Wiring Systems.
 - 4. Section 261430, Wiring Devices.
 - 5. Section 261700, Circuit and Motor Disconnects.
 - 6. Section 262000, Emergency Power Supply System:
 - a. Engine-generator sets.
 - b. Automatic transfer switches.
 - 7. Section 264020, Service Entrance.
 - 8. Section 264400, Switchboards.
 - 9. Section 264500, Grounding.
 - 10. Section 264510, Lightning Protection System.
 - 11. Section 264600, Dry-Type Transformers.
 - 12. Section 264710, Panelboards:
 - a. Lighting and appliance branch circuit panelboards.
 - b. Distribution panelboards.
 - 13. Section 264750, Overcurrent Protective Devices.
 - 14. Section 264760, Individual Circuit Breakers.
 - 15. Section 265100, Luminaires.
 - 16. Section 265910, Lighting Control Devices.
 - 17. Section 266140, Uninterruptible Power Supply.

18. Section 266710, Surge Protective Devices.
19. Section 274015, Audio-Visual Infrastructure and Raceway
20. Section 274126, Projection Screens

1.2 QUALITY ASSURANCE

- A. Provide an Electrical Performance Verification Supervisor with 10 years experience in electrical contracting. The Electrical Performance Verification Supervisor shall become familiar with the Owner's project requirements and the requirements of the performance verification process as defined in this Section, and if applicable, the commissioning process defined in Division 29. The Electrical Performance Verification Supervisor shall coordinate and execute the required performance verification activities.
- B. The Electrical Performance Verification Supervisor shall review submittal data for conformance with the requirements of the Project, shall monitor compliance with the requirements specified herein for storage and protection of equipment during construction, shall authorize the initial starting of equipment and systems in a manner to avoid damage to equipment, shall oversee start-up, testing, and shall document that the scheduled and specified performance requirements of each system have been accomplished.
- C. Conform to the following:
 1. ASHRAE Guideline 0.2-2015, Commissioning Process for Existing Systems and Assemblies.
 2. ASHRAE Guideline 4-2019 Preparation of Operating and Maintenance Documentation for HVAC&R Systems.
 3. NECA 90-2015.

1.3 PERFORMANCE VERIFICATION

- A. The Electrical Performance Verification Supervisor shall be responsible for scheduling, supervising, and coordinating and executing the start-up, testing, and performance verification activities as specified herein. Include and itemize the cost of performance verification in the contract price, and in each purchase order or subcontract written, include requirements for submittal data, performance verification efforts and documentation, operations and maintenance data, and training as specified herein.
- B. Electrical performance verification shall take place in three phases. Performance verification requirements for each phase are as follows:
 1. Construction Phase:
 - a. Attend a performance verification scoping meeting and additional such meetings, initially scheduled monthly until prefunctional testing of equipment and systems begins, and weekly thereafter during the construction phase to facilitate the performance verification process. The Electrical Performance Verification Supervisor shall coordinate meeting attendance with the Commissioning Authority.
 - b. Report in writing to the Commissioning Authority at least as often as performance verification meetings are scheduled, concerning the status of his activities as they affect the performance verification process, the status of each discrepancy identified during the prefunctional and functional testing process, explanations of any disagreements with the identified deficiencies, and his proposed resolution and schedule for correction of the deficiency.
 - c. Provide documentation of installed systems and equipment, and develop functional testing procedures. This documentation shall include detailed manufacturer installation, start-up, operating, troubleshooting and maintenance procedures; full details of any Owner-contracted tests; full factory testing reports, if any; and full warranty information, including responsibilities of the Owner to keep the warranty in force. In addition, the installation, start-up and check-out materials that are actually shipped inside the equipment and the actual field

- check-out sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Authority.
- d. Develop and submit to the Commissioning Authority for review and comment, prior to equipment or system start-up, a complete start-up and initial check-out plan using manufacturer's start-up procedures and prefunctional checklists for the performance of the equipment to be verified.
 - e. Assist in clarifying the proposed operation and control of equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
 - f. Prepare the specific functional test procedures as specified herein and review the proposed functional test procedures to ensure feasibility, safety, and equipment protection, and provide necessary written alarm limits to be used during the tests. Obtain Commissioning Authority approval for proposed functional test procedures.
 - g. Prepare a preliminary schedule for performance verification activities, including equipment start-up, and testing, adjusting and balancing start and completion, and update the schedule during the construction period, as appropriate. Notify the Commissioning Authority immediately when the performance verification activities not yet performed or not yet scheduled will delay construction.
 - h. Provide start-up and prefunctional testing for equipment and execute the electrical-related portions of the prefunctional checklists for the verification of the performance of all the equipment during the start-up and initial check-out process.
 - i. Perform and document start-up and system operational check-out procedures, providing a copy to the Commissioning Authority.
 - j. Correct noncompliance items before beginning functional testing. Discrepancies and problems shall be remedied before functional testing.
2. Acceptance Phase:
- a. Place equipment and systems into operation and continue their operation during each working day of the testing and performance verification activities, as required.
 - b. Provide skilled technicians to execute starting and prefunctional testing of equipment and to execute the functional tests for each individual piece of equipment and system. Technicians shall be available and present during the agreed upon scheduled tests and for sufficient duration to complete the necessary tests, adjustments and problem solving.
 - c. Perform functional testing for specified equipment and interpret the test data, as necessary under the direction of the Commissioning Authority.
 - d. Correct deficiencies (differences between specified and observed performance) as identified and interpreted by the Commissioning Authority and retest the equipment, as required to demonstrate proper operation and performance.
 - e. Prepare operation and maintenance manuals as specified, including clarifying and updating the original sequences of operation to as-built conditions.
 - f. Maintain marked-up record drawings and produce final record drawings of project drawings and contractor-generated coordination drawings.
 - g. Provide specified training of the Owner's operating personnel.
 - h. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
3. Warranty Period:
- a. Execute deferred functional testing.
 - b. Correct deficiencies and make necessary adjustments to operations and maintenance manuals and as-built drawings system or equipment modifications made during the warranty period and those identified in any deferred functional performance testing.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Standard testing equipment required to perform start-up, initial check-out, prefunctional, and required functional performance testing shall be provided by the contractor for the equipment or system being tested.
- B. Test equipment shall be of the quality and accuracy required to test and/or measure system performance with the tolerances specified and shall have been calibrated within the last 12 months, or as specified herein. Equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates available on request.
 - 1. Accuracy of sensors shall be at least twice that of the instrumentation being tested.

PART 3 - EXECUTION

3.1 SUBMITTALS

- A. Submit additional documentation as required to support the performance verification process. This additional submittal documentation shall include, at a minimum, the proposed start-up and initial check-out procedures, and prefunctional checklists.

3.2 START-UP PLAN AND PREFUNCTIONAL TESTING

- A. Prefunctional testing shall be required for each piece of equipment to ensure that the equipment and systems are properly installed and ready for operation, so that functional testing may proceed without delays. Follow the approved start-up, initial check-out, and prefunctional testing procedures. Sampling strategies shall not be used for prefunctional testing. The prefunctional testing for equipment and subsystems of a given system shall be successfully completed and documented prior to functional testing of the system.
- B. Procedures for performance verification shall include:
 - 1. Start-up and initial check-out plan: develop the detailed start-up and prefunctional testing plans for equipment and systems that are to be performance verified, as specified herein. Review the proposed procedures and prefunctional testing documentation to ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed.
 - 2. The start-up and initial check-out plan shall consist, as a minimum, of the following:
 - a. The manufacturer's standard written start-up and check-out procedures copied from the installation manuals and manufacturer's normally used field check-out sheets. The plan shall include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan.
 - b. First-run checklist for equipment, including:
 - 1) Equipment properly set.
 - 2) Adjustment of vibration isolators.
 - 3) Equipment properly connected.
 - 4) Completion of initial lubrication procedures.
 - 5) Wiring properly connected.
 - 6) Electrical overload relays appropriate for load.
 - 7) Electrical accessories properly installed and adjusted.
 - 8) Controls, safeties, and time switches properly set.
 - 9) Verification of direction of motor rotation after final electrical connections by jogging motor.

- 10) Measurement of amperage draw of electric motors and comparison with nameplate rating and with overload heater ratings.
 - 11) Monitoring of temperature build-up in motors and bearings.
 - c. Contractor-developed prefunctional checklists.
3. Prior to energizing, test cables and wiring for continuity, shorts, and circuitry, and correct short circuits, opens, and errors in circuiting. Field test circuits phase-to-phase, phase-to-neutral, phase-to-ground, and neutral-to-ground.
4. Overcurrent Protective Devices:
 - a. Set field-adjustable devices to dial and tap settings as scheduled in the approved overcurrent protective device coordination study subsequent to installation of units.
 - b. Prior to energizing overcurrent protective devices, test devices for continuity of circuitry and for short circuits. Correct malfunctioning units.
5. Start-up equipment and check-out operation in accordance with manufacturer's published procedures and with the procedures specified herein.
 - a. Submit report on equipment start-up and check-out with data from recorded findings.
6. In addition to other requirements specified herein, manufacturer shall provide services to start-up, check-out, and test the following equipment and systems:
 - a. Emergency power supply systems.
 - b. Switchboards.
 - c. Uninterruptible power supply.
7. Time switches: set for operation as directed by the Owner.
8. Emergency Power Supply System:
 - a. Upon completion of the installation, the emergency power supply system shall be tested to ensure conformity to the requirements of the NFPA 110-2019, both in power output and in function. The authority having jurisdiction, and the Owner, shall be given advance notification of the time the final test will be performed in order that the authority may witness these tests. The tests shall include performance test, full load test and cycle crank test, and shall be conducted and recorded as described in NFPA 110-2019.
 - b. Fill and top-off the fuel tanks after testing is completed.
9. Switchboards:
 - a. After complete installation, a certified electrical testing firm shall provide complete switchboard testing, including:
 - 1) Check for tightness of bolted connections.
 - 2) Check for bus bar bracing.
 - 3) Check that contact and joint resistances in circuit breakers are within manufacturer's tolerances.
 - 4) Check for installation and connection of equipment and circuits, and calibration or adjustment of meters, relays, remote controls, and other devices to ensure operation.
 - 5) Test to determine that circuit breaker trip devices are operating and adjusted.
 - 6) Test by high current injection method the ground fault protection of the switchboard devices, including selectivity. Certified reports shall be submitted indicating device settings, test current, and each device's measured tripping time, in cycles. In addition, the report shall include the name of the testing firm, date of the testing, and any deviations observed and corrective actions taken during the testing period.
10. Panelboards:
 - a. Prior to energizing, measure the resistance between the neutral bus and ground bus for lighting and appliance branch circuit panelboards. The measurement shall be made with the

feeder neutral disconnected. If the resistance is less than 1 megohm test each branch circuit for continuity, short circuits, or circuiting errors. Correct branch circuit problems. A final measurement of the panelboard shall be made and recorded after problems have been corrected.

11. Power Monitoring Equipment:

- a. Upon completion of the installation, the power monitoring equipment shall be tested to verify the following:
 - 1) Correct installation of current and potential transformers.
 - 2) Correct voltage, phase and frequency settings.
 - 3) Building network and/or building control system connectivity.
 - 4) Data logging and output report settings have been enabled.
 - 5) Monitor programming, data logging, output report settings, and provide output report of test event.

12. Grounding:

- a. Ground resistance shall be measured by a licensed professional engineer in accordance with IEEE 81-2012. Measurements shall be made with the grounding system isolated from the utility neutral. Results of the tests shall be submitted in a certified test report, bearing the seal of the test engineer. The certified test report shall include the following minimum data:
 - 1) Project name, date and location of test.
 - 2) Instrument serial number and type used.
 - 3) Sketch, showing layout of ground system and locations of test spikes.
 - 4) Measured ground resistance.

13. Luminaires:

- a. Luminaires shall be operational at the time of the substantial completion.

14. Lighting control systems: field-test circuits, phase-to-phase, phase-to-neutral, phase-to-ground, and neutral-to-ground. Check continuity, switches, and for short circuits and perform additional tests recommended by the manufacturer. Correct short circuits, opens and errors in circuiting.

- a. Adjust and set as directed by the Architect including the light levels of each zone in each scene and set up of control accessories.
- b. Start-up, calibrate and test daylighting control systems per manufacturer's written installation instructions.
 - 1) Controls shall be calibrated after room finishes and furniture are installed. Room finishes and furniture shall include, but not be limited to, paint, carpet, ceiling tiles, shades or blinds, and large artwork. Window treatments shall be installed and operable.
 - 2) Controls shall be calibrated under consistent daylight conditions. Controls shall not be calibrated under overcast or intermittent cloud cover sky conditions.

15. Uninterruptible power supply: as specified in Section 266140, Uninterruptible Power Supply.

- C. Identify which trade is responsible for executing and documenting each of the line item tasks and note that trade on the form. Each form may have more than one trade responsible for its execution.
- D. The Commissioning Authority reserves the right to witness the above described tests, checks and inspections. Notify the Commissioning Authority at least 10 days prior to the date scheduled for the tests.
- E. Four weeks prior to start-up, schedule equipment and systems start-up and check-out and notify the Commissioning Authority in writing. The execution of the prefunctional checklists, start-up and check-out shall be directed and performed by the Contractor, in accordance with manufacturer's published procedures.

The Commissioning Authority shall be present for the start-up, check-out, and prefunctional testing of the first unit of each type of equipment, and any other tests he designates.

- F. Sensor calibration: calibration of sensors associated with a given piece of equipment or system shall be included as part of the prefunctional testing and listed on the appropriate test checklists and reports for that system.
- G. Completed start-up, check-out, and prefunctional test forms shall be completed and submitted to the Commissioning Authority for review. List outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies shall be provided to the Commissioning Authority within 2 days of test completion. The Commissioning Authority shall review the Contractor's start-up and prefunctional testing reports and shall submit either a noncompliance report or an approval form to the Contractor. The Contractor shall correct items that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the Commissioning Authority as soon as outstanding items have been corrected and resubmit an updated start-up report and a statement of correction on the original noncompliance report. When requirements are completed, the Commissioning Authority shall recommend approval of the start-up and prefunctional testing of each system and schedule the functional testing of the equipment or system.
- H. Complete start-up and prefunctional testing for a system before functional testing of that system may proceed.

3.3 RETESTING OF EQUIPMENT AND/OR SYSTEMS

- A. Provide labor and materials required for retesting of any functional test found to be deficient.
- B. Prior to retesting, submit required data indicating that the deficient items have been completed and/or corrected to the Commissioning Authority for approval and rescheduling of the functional test. If during the retesting it becomes apparent that the deficient items have not been completed and/or corrected as indicated in the data provided by the Contractor, the retesting shall be stopped. Costs for the design team to further supervise the retesting of a functional test shall be the responsibility of the Contractor.

3.4 DEFERRED TESTING

- A. Schedule and coordinate, with the approval of the Commissioning Authority, any required tests delayed until building construction is completed, required building occupancy or loading, or other conditions are suitable for the demonstration of equipment or system's performance, as specified herein. Deferred testing shall be executed, documented, and deficiencies corrected as specified herein for functional testing. Adjustments or corrections to the operation and maintenance manuals and as-built documents required by the results of the testing shall be made before the seasonal testing process is considered complete.

3.5 TESTING DOCUMENTATION, NONCONFORMANCE, AND APPROVALS

- A. List outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the functional test procedure forms or on an attached sheet. Procedure forms and any outstanding deficiencies shall be provided to the Commissioning Authority within 2 days of test completion. The Commissioning Authority shall review the Contractor's start-up and prefunctional test reports and shall submit either a noncompliance report or an approval form to the Contractor. The Contractor shall work with the Commissioning Authority to correct and retest deficiencies or uncompleted items. Correct items that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the Commissioning Authority as soon as outstanding items have been corrected and resubmit an updated start-up report and a statement of correction on the original noncompliance report. When

requirements are completed, recommend approval of the start-up and prefunctional testing of each system and schedule the functional testing of the equipment or system.

- B. As functional performance testing progresses and deficiencies are identified, work with the Commissioning Authority to resolve the issues.

3.6 OPERATION AND MAINTENANCE DOCUMENTATION PACKAGE

- A. The Electrical Performance Verification Supervisor shall compile and prepare documentation for equipment and systems covered in Division 26 and deliver this documentation for inclusion in the operation and maintenance manuals prior to the training of the Owner's personnel.

3.7 INSTRUCTION OF OPERATING PERSONNEL

- A. The Electrical Performance Verification Supervisor shall schedule, coordinate, assemble and deliver the documentation of the training required by this Division.

3.8 FUNCTIONAL TESTING

- A. Functional test requirements for the demonstration of proper system and equipment operation shall be defined by the Electrical Performance Verification Supervisor. Execution of these tests and demonstrations of the required performance shall be the responsibility of the Contractor under the direction of the Commissioning Authority.
- B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or subsystems at the discretion of the Commissioning Authority. Beginning system testing before full completion of construction shall not relieve the Contractor from fully completing the system, including prefunctional checklists.
- C. Functional testing shall be completed and approved by the Commissioning Authority before the Project will be considered substantially complete.

END OF SECTION 260090

SECTION 261100 - RACEWAYS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other electrical systems are specified in other Sections of Division 26.
- B. This Section covers raceways for electrical, telephone, data, and fire alarm, and communications, and security wiring.
- C. This Section includes responsibilities and obligations in support of the performance verification specified in Section 260090, Electrical Performance Verification.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. NECA 101-2013.
 - 2. NECA 111-2003.
 - 3. North Carolina State Electrical Code-2018.
- B. Conduit sizes specified herein or indicated on the Drawings refer to the standard trade sizes, are for identification purposes only, and are not actual dimensions.

PART 2 - PRODUCTS

2.1 ELECTRICAL METALLIC TUBING

- A. Galvanized steel.
- B. Connectors and couplings shall be malleable iron or steel, galvanized or cadmium-plated, compression type.
- C. Connectors shall have insulated throats.
- D. Manufacturer: Allied Tube & Conduit, Republic Conduit, Western Tube & Conduit, or Wheatland Tube.

2.2 FLEXIBLE METAL CONDUIT

- A. Galvanized steel.
- B. Connectors shall be of the twist-in, insertion or totally enclosed clamp type, galvanized malleable iron or steel, with insulated throats.
- C. Manufacturer: Alfex, American Flexible Conduit, Cerro Wire & Cable, or Steelflex Electro.

2.3 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- A. Extra flexible type, neoprene-jacketed.

- B. Connectors shall be watertight, of the twist-in, insertion type, galvanized malleable iron or steel, with insulated throats.
- C. Manufacturer: Alfex, American Flexible Conduit, International Metal Hose, or Universal Metal Hose.

2.4 RIGID METAL CONDUIT

- A. Galvanized steel.
- B. Connectors and couplings shall be threaded galvanized malleable iron or steel.
- C. Locknuts shall be of the type with sharp edges that bite into enclosure where connected.
- D. Plastic insulating bushings shall be high temperature type.
- E. Sealing bushings shall have galvanized malleable iron locking ring with molded neoprene sealing ring with predrilled holes to accommodate each individual conductor, stainless steel screws and washers, PVC-coated pressure discs, and factory-installed lay-in grounding conductor lugs.
- F. Hub fittings shall be 2-piece, insulated throat, liquidtight type of steel or malleable construction.
- G. Manufacturer: Allied Tube & Conduit, Republic Conduit, Western Tube & Conduit, or Wheatland Tube.

2.5 RIGID NONMETALLIC CONDUIT

- A. Rigid nonmetallic conduit shall be rigid polyvinyl chloride, nonburning, high impact, schedule 40.
- B. Couplings and connectors shall be rigid polyvinyl chloride, high impact, schedule 40.
- C. Cement for connections of conduit shall be approved by the conduit manufacturer.
- D. Manufacturer: Cantex, Carlon, Plastiline, or Queen City Plastics.

2.6 INDOOR SERVICE POLES

- A. Indoor service poles shall be color as selected by the Architect, with 2 separate compartments, each with a removable cover.
- B. One compartment shall be prewired and equipped with 2 duplex receptacles rated at 15 A, 125 V. Factory installed conductor leads shall extend 6" out of the top for splicing to overhead wiring.
- C. The second compartment shall be for field installation of telephone, communication, or electronic wiring. Minimum capacity shall be large enough to accommodate 4-25 pair telephone cables with a 30% fill.
- D. Foot assemblies: adjustable chromium-plated stanchions.
- E. Pole length: as required by ceiling height.
- F. Provide fittings, trimplates, and mounting brackets for a complete installation according to the manufacturer's recommendations.
- G. Manufacturer: 3M, Walker, or Wiremold.

2.7 ACCESSORIES

- A. Pull lines: minimum tensile strength of 200 lb. Pull lines in nonmetallic conduit shall be galvanized steel wire.
- B. Expansion fittings: concretetight with ground continuity.
 - 1. Manufacturer: Appleton, Crouse-Hinds, or O-Z/Gedney.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install conductors in raceways, unless otherwise specified herein.
- B. Raceways shall be concealed above ceilings, in walls, floors, or underground. Raceways shall be exposed where indicated on the Drawings or as specified herein.
- C. Unless otherwise indicated on the Drawings or specified herein, minimum raceway size shall be 0.75". Minimum raceway size for telephone, communications, and data cable shall be 1". 0.375" flexible connections to recessed luminaires are acceptable.
- D. Install the raceway systems, where indicated on the Drawings, complying with manufacturer's written instructions.
- E. The raceway installation shall follow the layout indicated on the Drawings. Changes in the location, and offsets to accommodate building conditions, and coordination with the work of other trades, including equipment, piping and ductwork, shall be made prior to initial installation, without additional cost to the Owner. Offsets in conduit are not indicated on the Drawings and shall be furnished.
- F. Unless otherwise indicated on the Drawings, route raceways tight to the underside of the structure and above ceilings. Offset raceways below obstructions.
- G. Where raceways must pass through structural members, obtain approval from the Architect regarding location and size of openings prior to drilling.
- H. Raceways that pass through expansion joints shall be provided with expansion fittings.
- I. Raceway penetrations through the roof shall be made with prefabricated fittings. Coordinate with the roof system manufacturer.
- J. Raceways shall be run parallel with or at right angles to the building walls.
- K. Lateral raceways in masonry shall not exceed 0.75".
- L. Raceways shall be secured in place and protected to prevent damage to the work during construction. Refer to Section 261900, Supporting Devices for support requirements and methods.
- M. Open ends of raceways shall be taped or capped after installation to prevent entry of dirt and debris during construction prior to pulling wire.
- N. Installation of raceways shall be complete and shall be blown-out and swabbed clear of water and trash prior to pulling wire.

- O. Running threads shall not be used for threaded connections on rigid metal conduit. Conduit threading shall be limited such that the joint is watertight and that not more than 1-1.5 threads are exposed after conduit is tightened in fittings or threaded box openings.
- P. Exposed threads or field-cut edges of conduits shall be immediately coated with a galvanizing compound after installation.
- Q. Make connections to motors, not near walls or columns, with a vertical rigid metal conduit, minimum size 0.75" attached to floor and ceiling. Wiring shall be carried into and out of this conduit by means of condulets and flexible conduit.
- R. Install junction or pull boxes to avoid excessive runs or bends. Several such boxes are indicated on the Drawings. The locations shown may be varied and additional boxes installed. Refer to Section 261300, Boxes for specific box types and requirements.
- S. Provide pull lines in empty raceways. At each end, leave 12" of slack coiled in the box, or at the end of the conduit where boxes are not installed, and secure at each end.

3.2 ELECTRICAL METALLIC TUBING

- A. Electrical metallic tubing shall be installed for:
 - 1. Raceways in concrete and masonry construction above grade, in hollow spaces in columns and walls, and above ceilings.
 - 2. Exposed raceways in unfinished areas.
- B. Electrical metallic tubing stubbed-up from floor slabs or down from ceiling plenums and not connected to an enclosure shall terminate with an insulated throat connector.

3.3 FLEXIBLE METAL CONDUIT

- A. Flexible metal conduit shall be installed for:
 - 1. Connections to recessed luminaires, maximum 72" length.
 - 2. Connections to motors and busway plugs.
 - 3. Connections to electrical equipment subject to movement or vibration.
 - 4. Connections to equipment in dry locations mounted on vibration isolators, and to dry-type transformers mounted on external vibration isolators, minimum length of 18" or 12 times the nominal diameter of the conduit, whichever is larger.

3.4 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- A. Liquidtight flexible metal conduit shall be installed for:
 - 1. Connections to motors in damp or wet locations.
 - 2. Connections to electrical equipment subject to movement or vibration where exposed to rain, spray, or a corrosive atmosphere.
 - 3. Connections to equipment subject to oil or grease.
 - 4. Connections to fire pumps and auxiliary equipment.

3.5 RIGID METAL CONDUIT

- A. Rigid metal conduit shall be installed for:
 - 1. Exposed raceways outside of the building.

2. Exposed raceways serving fire pumps, jockey pumps, and fire pump control equipment.
3. Exposed telecommunications entrance conduit.
4. Exposed service entrance conduit.
5. Feeder conduit within the building.
6. Conduits containing emergency power supply system signal and control wiring.
7. Raceways underground beneath building slab.
8. Applications not otherwise specified herein.

- B. Conduit shall be secured to metal enclosures using hub fittings.
- C. Insulated bushings or fittings shall be installed at connections to cabinets and boxes. Terminate stub-ups not attached to enclosures with an insulated throat grounding bushing.
- D. Commercial pipe joint compound shall be applied to the male threads on threaded joints and fittings.
- E. Connections shall be wrenchtight, and where subject to ground water, rain or spray shall be watertight.
- F. Field treat conduit and fittings buried in earth or gravel with one of the following:
 1. 2 coats of asphaltum.
 2. Spiral wrapped, half-lapped, 20 mil plastic tape.

3.6 TELEPHONE AND DATA RACEWAYS

- A. Service raceways shall be installed as indicated on the Drawings and shall be coordinated with the service provider.
- B. Raceways terminated at wood backboards shall be turned-up out of the floor slab to 12" above the finished floor if routed from below, and turned down and terminated 12" above the top of the backboard if routed from above.
- C. Install in accordance with TIA 569-E-2-2019.

3.7 RIGID NONMETALLIC CONDUIT

- A. Rigid nonmetallic conduit shall be used for exterior underground and specific applications where indicated on the Drawings.
- B. An insulated copper grounding conductor shall be installed in each plastic conduit unless prohibited by local codes or utility company. Grounding conductors shall be bonded to grounded metal enclosures or devices at origin and at each outlet. Refer to Section 264500, Grounding for specific requirements and methods.
- C. Rigid nonmetallic conduit shall not be stubbed up above the finished floor for attachment to boxes, outlets, or equipment. A transition to rigid metal conduit shall be made a minimum of 18" horizontally from each stub-up.

3.8 RACEWAY SLEEVES AND SEALING

- A. Provide sleeves and fire stopping for raceways penetrating floors and partitions as specified in Section 260010, Electrical General.
- B. Install conduit sealing bushings on conduits that penetrate slabs or walls below grade.

- C. Conduits entering refrigerated spaces, and hazardous areas, shall be installed with sealing fittings listed for the specific application to prevent entrance of moisture and explosive substances.
- D. Raceways installed between luminaires and outlets exposed to weather and interior conditioned space shall be sealed with nonhardening elastic duct sealant at the last outlet in the conditioned space.

3.9 INDOOR SERVICE POLES

- A. Service poles shall be installed with an adhesive pad when installed on carpet and a screw mounted plate or pedestal when installed on hard surface floors.
- B. Final connections to poles shall be made with flexible metal conduit. Inside area of conduit shall be as large as wiring space inside pole.

END OF SECTION 261100

SECTION 261120 - CABLE TRAYS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other electrical systems are specified in other Sections of Division 26.
- B. This Section covers cable trays for power, security, audio visual, telephone, communications, and data cable.
- C. This Section includes responsibilities and obligations in support of the performance verification specified in Section 260090, Electrical Performance Verification, and commissioning specified in Section _____.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. NECA/NEMA 105-2015.
 - 2. NFPA 70-2020.
 - 3. North Carolina State Electrical Code-2018.
 - 4. National Electrical Code-2017 with South Carolina Modifications-2020.
 - 5. TIA 569-E-2-2019.

PART 2 - PRODUCTS

2.1 CABLE TRAYS

- A. Cable trays shall form a wireway system and shall be the ladder type, nominal 4" depth, aluminum or steel construction. Cable trays shall include splices, end plates, dropouts, expansion connectors in straight runs of 125' or longer, 1 2 barrier strips, and support/accessory items for a complete installation. Edges, fittings, and hardware shall be finished free from burrs and sharp edges. Steel cable trays shall be powder-coated black _____ after fabrication. Load-carrying ability of fittings shall be not less than the straight tray sections, and fittings shall have a minimum 12" radius, unless otherwise indicated on the Drawings.
 - 1. Cable trays shall be classified by UL and rated as an equipment grounding conductor.
 - 2. Trays shall have 6" 9" rung spacing. Rungs shall have depth and cross section for the tray width and loading specified herein and shall be welded to the side rails for rigidity and elimination of loose joints. Tray widths shall be as indicated on the Drawings.
 - 3. Cable trays shall be designed for a uniformly distributed cable load of 75 lb/ft when supported on 8' spans.
 - 4. Manufacturer: B-Line Systems, Mono-Systems, MP-Husky, or Legrand.
- B. Cable trays shall form a wireway system and shall be the wire basket type, nominal 2" 4" depth, steel construction. Cable trays shall include splices, end plates, dropouts, expansion connectors in straight runs of 125' or longer, radius bends, 90° bends, and support/accessory items for a complete installation. Edges, fittings, and hardware shall be finished free from burrs and sharp edges. Load-carrying ability of fittings shall be not less than the straight tray sections.
 - 1. Cable trays shall be galvanized steel, steel, galvanized after fabrication, steel with a factory applied black finish, stainless steel.
 - 2. All changes in direction shall use factory fabricated turns and crosses with a 6" minimum bend radius.

3. Cable trays shall be classified by UL and rated as an equipment grounding conductor.
4. Trays shall be 0.191" minimum wire gauge construction. Tray shall be designed for a uniformly distributed cable load of 32 lb/ft when supported on 8' spans.
5. Manufacturer: B-Line, Cablofil, Flextray, Gulf Coast Systems, Mono-Systems, or Chatsworth CPI.

PART 3 - EXECUTION

3.1 GENERAL

- A. Comply with manufacturer's written instructions.
- B. Cable trays shall be secured in place and protected to prevent damage to the work during construction. Refer to Section 261900, Supporting Devices for support requirements and methods.
- C. Exposed threads or field-cut edges of cable trays shall be immediately coated with a galvanizing compound after installation.
- D. Support 8' on center, unless otherwise indicated on the Drawings, with 0.5" threaded rods and unistrut channel mounts trapeze supports on both sides.
- E. Cables shall be attached with hook-and-loop tape to rungs and wire frame in horizontal runs to maintain cable arrangements and attached with hook-and-loop tape to rungs and wire frame in vertical runs to provide uniform cable weight distribution. Cable risers shall be supported with cable grips to avoid transfer of vertical cable loads to upper cable support systems or equipment terminations. Bundles shall not exceed 25 cables.
- F. Provide a bonding jumper or strap at each joint.
- G. Install in accordance with TIA 569-E-2-2019.

3.2 LOCATION

- A. In general, the cable tray installation shall follow the layout indicated on the Drawings. This layout is, however, diagrammatic only. Changes in the location, and offsets to accommodate building conditions, and coordination with the work of other trades, including equipment, piping and ductwork, shall be made prior to initial installation, without additional cost to the Owner. Offsets in conduit are not indicated on the Drawings and shall be furnished.
- B. Unless otherwise indicated on the Drawings, cable trays shall be installed under all mechanical, electrical and structural building systems and above lay-in ceilings. Offset cable trays below obstructions.
- C. Cable trays shall be run parallel with or at right angles to the building walls.
- D. Cable trays shall be located to maintain a minimum 6" clearance above and 9" on both sides.
- E. The exact routing of new exposed cable trays shall be approved by the Owner before installation.

3.3 COORDINATION

- A. Where cable trays must pass through structural members, obtain approval from the Architect Engineer regarding location and size of openings prior to drilling.

- B. Cable trays that pass through expansion joints shall be provided with expansion fittings.
- C. Where cable trays penetrate through the roof special detailed drawings shall be provided indicating the method utilized to maintain the integrity of the roof structure. Coordinate with the roof system manufacturer.
- D. Where cable trays pass above inaccessible ceiling spaces of spans greater than 6' in length, provide 4" empty conduits (quantities as required to provide a cross sectional area equivalent to the associated cable tray section) in place of cable trays. Conduits shall be provided with insulated bushings on both ends and shall be bonded to cable trays.

3.4 PENETRATIONS AND SEALING

- A. Provide penetrations and fire stopping for cable trays penetrating floors and partitions as specified in Section 260010, Electrical General.

END OF SECTION 261120

SECTION 261150 - UNDERGROUND DUCTS, MANHOLES AND HANDHOLES

PART 1 – GENERAL

1.1 DESCRIPTION

- A. General provisions and other electrical systems are specified in other sections of Division 26.
- B. This Section covers underground ducts, manholes and handholes to form underground raceway systems for power and signal conductors.
- C. Underground warning tape is specified in Section 260010, Electrical General.
- D. This Section includes responsibilities and obligations in support of the performance verification specified in Section 260090, Electrical Performance Verification, and commissioning specified in Section_____.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. ACI 318-2019.
 - 2. ASTM C478-2019.
 - 3. NECA/NEMA 605-2018.
 - 4. North Carolina State Electrical Code-2018.

PART 2 - PRODUCTS

2.1 CONDUITS

- A. As specified in Section 261100, Raceways.

2.2 MISCELLANEOUS

- A. Sealing devices: malleable iron, watertight, gland type with integral flanges and pressure bushings at each end.
- B. Spacers: rigid, PVC type.
- C. Concrete: as specified in Section 260010, Electrical General, except 28 day compressive strength shall be 4000 psig.
- D. Innerduct liners: corrugated high density orange polyethylene, with an inner diameter of 1".

PART 3 - EXECUTION

3.1 GENERAL

- A. Unless indicated otherwise on the Drawings, the following types of construction shall be used:
 - 1. Electrical service and circuits exceeding 5 kV or 800 A:

- a. Concrete-encased nonmetallic rigid conduit.
- 2. Telephone and data service:
 - a. Concrete-encased nonmetallic rigid conduit.
- 3. Electrical circuits other than those specified above:
 - a. Nonmetallic rigid conduit without concrete encasement.
- 4. Telephone and data conduits:
 - a. Nonmetallic rigid conduit without concrete encasement.
- 5. Manholes and handholes:
 - a. Precast, or cast-in-place concrete.
- B. Excavation and backfill: as specified in Section 260010, Electrical General.
- C. Concrete formwork, and reinforcing: shall conform to Division 03, Concrete.

3.2 DUCT LINE INSTALLATION - GENERAL

- A. Slope ducts to drain towards manholes and handholes, and away from buildings and equipment entrances. Minimum pitch shall be 4" per 100'. Where it is not possible to avoid a trap or low point in a duct which is not concrete encased, provide a 0.5" hole drilled in the bottom of the conduit at the low point and a crushed stone sump below the conduit. If possible, install the sump above the high water table elevation. Otherwise prevent the accumulation of water within the conduit.
- B. Offset ducts to avoid conflicts with existing underground obstructions.
- C. Curved sections in duct lines shall consist of long sweep bends with a minimum radius of 50' in the horizontal and vertical directions. Manufactured bends with a minimum radius of 48" shall be limited to building entrances and stub-ups to equipment.
- D. The portion of underground conduit run under building slabs shall be rigid galvanized steel and extend a minimum of 5' outside the building or slab foundation. Stub-ups to equipment mounted on outdoor concrete slabs shall be rigid galvanized steel and shall extend a minimum of 5' away from the edge of the slab. Install insulated grounding bushings on the terminations of metallic conduit.
- E. Keep ducts clean of dirt, sand, or gravel during construction, and sealed with tapered plugs upon completion of each portion of the work.
- F. Upon completion of the duct line installation, pull a flexible mandrel through each conduit to loosen particles of dirt, sand, or foreign material. Mandrels shall be not less than 12" long, and shall have a diameter 0.5" less than the inside diameter of the conduit. A brush with stiff bristles slightly larger than the conduit diameter shall then be pulled through each duct to remove the loosened particles.
- G. Seal ducts and conduits at building entrances, and at outdoor terminations for equipment, with a nonhardening compound.
- H. Conduit extending up utility service poles shall be terminated in the manner required by the utility.
- I. Conduits shall be terminated in end bells, spaced approximately 9" on center at the face of manhole walls for 4" conduits, and proportionately spaced for other sizes. The change from regular conduit spacing to end bell spacing shall start 10' from the face of the manhole wall and shall be made in such a way that the slope of any conduit shall not be less than that of the main bank and no trap will be formed.

- J. Joints in conduits and fittings shall be made watertight. Threaded portions of conduits that are not to be encased in concrete, and adjoining ends of conduits, couplings and fittings, shall be heavily coated with asphaltum after installation. Connections between conduits of different types shall be made using adapters and methods recommended for the purpose by the conduit manufacturers.
- K. Where an underground conduit enters the building through a membrane-waterproofed wall or floor, a sealing device shall be provided. Where a concrete envelope is required the sealing device shall be on the inside only. Devices shall be securely anchored into masonry construction. Membrane waterproofing shall be secured to the device in a permanently watertight manner.
- L. Conduits entering a building shall be sealed at the first termination with oakum or a plastic expandable compound.
- M. Where an underground conduit, not concrete encased, enters the building through a nonwaterproofed wall or floor, provide a sleeve made of schedule 40 galvanized pipe. The space between the conduit and the sleeve shall be filled with plastic expandable compound or an oakum and lead joint on each side of the wall or floor. Sealing devices specified herein are acceptable in lieu of sleeves.
- N. Conduits shall be straight between manholes or upturned elbows. Where bends are unavoidable in nonmetallic conduits, they may be made by assembling couplings at a slight angle, provided the watertight seals are not broken and the resulting radius is not less than 100'. For radii less than 100', 5° angle couplings or 5° factory-made bend sections shall be used.
- O. Multiple conduit runs, direct burial or concrete encased, shall be supported on preformed, nonmetallic separators. Spacing between exterior surfaces of conduits generally shall be not less than the following: 3" between conduits containing cables operating at similar voltage, and 6" between signal conduit and any power conduit in the same envelope. Spacing between separators shall be close enough to prevent sagging of conduits or breaking of couplings or watertight seals and to keep deformation of conduit at the separators to 0.1" or less. Separators shall be secured with cords where necessary. No tie wires, reinforcing rods or other metallic materials shall be placed in direct contact with conduits, either individually or in groups.
 - 1. Multiple conduit runs shall be arranged substantially as indicated on the Drawings, but minor changes in location or cross sectional arrangement shall be made as necessary to avoid obstructions. Where conduit runs cannot be installed as shown because of conditions not discoverable prior to digging of trenches, notify the Architect. Underground conduits shall be coordinated with other outside utility work. Existing outside utilities shall be maintained in operation unless otherwise directed. Where conduits cross under existing roadways, walks or other paved areas, rigid metallic conduits may be driven under such areas in lieu of installing the conduits in trenches. After installation of conduit, existing paved or grass areas which have been disturbed in any way shall be restored to their original condition. Where the Drawings indicate spare conduits under existing roadways, walks, and other similar paved areas, ends of conduits shall be capped 5' beyond the pavement. The ends of these conduits shall be marked by the placement of 6" diameter by 18" long concrete monuments set flush in ground permanently identified "Spare Conduit".

3.3 CONCRETE-ENCASED DUCTS

- A. Spacers shall be installed maximum 5' on center, and shall support and maintain uniform spacing of the duct assembly a minimum of 3" above bottom of the trench during the concrete pour.
- B. Extend the concrete envelope encasing the ducts at least 3" beyond the outside walls of the outer conduits.
- C. Where new ducts, conduits, and concrete envelopes are to be joined to existing manholes, handholes, ducts conduits, and concrete envelopes, make joints with fittings and fabricate the concrete envelopes to ensure smooth transitions.

- D. Envelopes may be poured directly against the sides of the trenches if the cut is clean, even and free of loose material. Forms are required where the soil is not self-supporting. Loose dirt and extraneous material shall be removed from the trenches before and during pouring of concrete. Concrete shall be carefully spaded during pouring to eliminate voids under and between the conduits and honeycombing of the exterior surfaces. Power driven tampers or agitators shall be specifically designed for the application.
- E. Each run of envelope between manholes shall be poured in one continuous operation. Where more than one pour is necessary, each pour shall terminate in a vertical plane, and 0.75" reinforcing rod dowels shall be provided at each corner of the duct line and between exterior conduits, 1.5" from the exterior surface, extending 18" into the concrete on each side of the joint.
- F. Where an envelope is installed over disturbed earth, across other conduits or pipe lines, or under paved areas such as roads, driveways, or parking areas, it shall be reinforced. Reinforcement shall also be provided where envelopes connect to manhole and building walls. Where envelopes are terminated for future extension, dowels shall be provided as specified herein for joints between pours.
 - 1. Reinforcement at connections to buildings, manholes, and handholes shall extend 10' from the point of connection.
 - 2. Reinforcement at conduit and pipe line crossings and at crossing of areas of disturbed earth shall extend 10' beyond the crossing.
 - 3. Envelopes reinforced under paved areas shall include envelopes within 10' of the paved areas.
 - 4. Minimum reinforcement shall consist of No. 4 steel reinforcing bars located longitudinally 1.5" inside the envelope surfaces at each of the four corners of the concrete envelope with No. 3 steel reinforcing ties located 2' on center.
 - a. In multiconduit ducts, additional intermediate reinforcing bars shall be located in a single layer 1.5" above the bottom of the concrete envelope. Locate intermediate reinforcing bars in each space between the conduits in the lowest row.
 - b. In multiconduit ducts under paved areas, additional intermediate reinforcing bars shall be located in a single layer 1.5" above the bottom of the concrete envelope and in a single layer 1.5" below the top of the concrete envelope. Locate intermediate reinforcing bars in each space between the conduits in the lowest row and in the highest row.
- G. The top surface of electrical ducts containing conductors of systems rated 300 V to ground or higher shall be painted red for permanent duct bank identification.

END OF SECTION 261150

SECTION 261200 - BUILDING WIRE AND CABLE, 600 VOLT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other electrical systems are specified in other Sections of Division 26.
- B. This Section covers building wire, cable, and associated connection devices and accessories rated for 600 V.
- C. Wiring for communications and alarm systems is covered in other Sections of Division 26.
- D. This Section includes responsibilities and obligations in support of the performance verification specified in Section 260090, Electrical Performance Verification, and commissioning specified in Section_____.

1.2 QUALITY ASSURANCE

- A. Specified conductor size refers to American Wire Gauge (AWG).
- B. Conform to the following:
 - 1. North Carolina State Electrical Code-2018.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Conductors shall have outer covering color-coded the entire length to indicate phase, neutral, and ground conductors. Colors shall be as follows:

<u>Conductor</u>	<u>208/120 V Systems</u>	<u>480/277 V Systems</u>
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	White	Gray
Ground	Green	Green
Isolated Ground	Green/Yellow	Green/Yellow

2.2 CONDUCTORS

- A. Conductors shall be copper. Sizes indicated on the Drawings or specified herein refer to copper conductor sizes.
- B. Conductors shall be a minimum of #12 AWG unless otherwise specified herein. Conductors #8 AWG and larger shall be stranded.
- C. Insulation shall be type THHN/THWN-2 or XHHW-2, 600 V, rated at 90°C.
- D. Luminaire wiring shall be high temperature fixture or machine tool wire.

- E. Lay-in luminaires equipped with UL listed 72" flexible metal conduit and connector assemblies shall be prewired with minimum #18 AWG conductors in the flexible assembly.
- F. Conductors shall have size, grade of insulation, voltage, and manufacturer permanently marked on the outer cover at intervals not exceeding 24".
- G. Manufacturer: Aetna, Cerrowire, Colonial, Encore, General Cable, Pirelli, Southwire, or United Copper Industries.

2.3 CONNECTION DEVICES FOR COPPER CONDUCTORS

- A. For splices and taps on conductors #10 AWG and smaller, connection devices shall be twist-on or crimp pressure type.
- B. Splices, taps and bus bar terminations of conductors #8 AWG and larger shall be made with compression, crimp type connection devices.
- C. Manufacturer: 3M, Ideal, Panduit, or Thomas & Betts.

2.4 ACCESSORIES

- A. Electrical tape: high voltage splicing, filler, and vinyl plastic electrical type.
 - 1. Manufacturer: 3M, Anixter Brothers, or Plymouth.
- B. Connection covers: plastic type.
 - 1. Manufacturer: Ideal, Panduit, or Thomas & Betts.
- C. Pulling compound: shall not deteriorate conductors or insulation.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

- A. Install in each raceway a minimum of 3 #12 AWG conductors, including ground conductors, unless otherwise specified herein or indicated on the Drawings.
- B. Branch Circuit Homeruns:
 - 1. For 120 V, 20 A circuits 75' or greater provide #10 AWG homerun conductors.
 - 2. For 277 V, 20 A circuits 150' or greater provide #10 AWG homerun conductors.
- C. Install wiring, cables, and connection devices in accordance with the manufacturer's instructions.
- D. Install conductors in raceways unless specifically indicated otherwise on the Drawings.
- E. Conductors in one raceway shall be installed at one time, using pulling compound.
- F. Conductors in panelboards, switchboards, and control cabinets shall be grouped and laced with nylon tie straps.
- G. No more than three branch circuit homeruns shall be installed in a conduit.

- H. Connect each circuit of a multicircuit home run to a different phase at the panelboard.
- I. 120 V Single-phase line-to-neutral branch circuits shall be provided a separate dedicated neutral conductor for each branch circuit. Multiwire branch circuits with shared or common neutrals are not acceptable.
- J. Where multiple single-phase line-to-neutral branch circuits are spliced within a common box or enclosure each phase and neutral conductor shall be identified with corresponding panel and circuit number at each splice.
- K. Support cable risers. See Section 261900, Supporting Devices for specific supporting methods.
- L. Termination of more than 1 conductor in a single terminal is not acceptable except where the terminal is approved by the manufacturer for such application.

3.2 COPPER CONNECTION DEVICES

- A. Dies for compression tools shall be as recommended by the manufacturer for each conductor size involved.
- B. Connectors shall exert positive pressure to the conductors.

3.3 CONNECTIONS TO MECHANICAL EQUIPMENT

- A. Locations of motors, equipment, and apparatus indicated on the Drawings are approximate and connections shall be made to such equipment where actually installed.

3.4 JOINT COVERING

- A. Cover electrical connections with successive layers of high voltage filler putty or splicing tape, varnished cambric tape, and vinyl plastic electrical tape to cover rough edges and to provide insulation equal to that of conductor insulation.

3.5 IDENTIFICATION

- A. Switch legs shall be color-coded the same as phase conductors.

END OF SECTION 261200

SECTION 261300 - BOXES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other electrical systems are specified in other Sections of Division 26.
- B. This Section covers outlet boxes, junction and pull boxes, and conduit bodies.
- C. This Section includes responsibilities and obligations in support of the performance verification specified in Section 260090, Electrical Performance Verification, and commissioning specified in Section_____.

1.2 QUALITY ASSURANCE

- A. Outlet boxes, junction and pull boxes, and conduit bodies shall be UL listed. Equipment installed in hazardous locations or corrosive atmospheres shall be listed for the specific application.
- B. Conform to the following:
 - 1. North Carolina State Electrical Code-2017.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Boxes shall be the type, size and configuration required for its specific use, location, device or luminaire, and number, size, and arrangement of raceways connecting thereto.

2.2 OUTLET BOXES

- A. Construction: code-gauge galvanized steel, unless otherwise specified herein or indicated on the Drawings.
- B. Where installed in hazardous locations, or exposed to corrosive atmosphere, rain or spray, boxes shall be corrosion resistant cast metal with threaded entrances, removable covers, gaskets, and corrosion resistant screws.
- C. Recessed boxes in plaster or gypsum board walls or columns shall be 4" or 4.688" square, 2.125" deep with plaster rings.
- D. Surface-mounted boxes on walls or columns shall be 4" square, 2.125" deep, with no plaster rings or knock-outs.
- E. Switch boxes with only one conduit entrance shall be single gang.
- F. Boxes for devices recessed in metal door jambs shall be sheet metal partition boxes sized for the application.
- G. Recessed boxes in masonry walls shall be square cornered masonry boxes or standard 4" square boxes fitted with square cornered tile covers of proper depth for block. Both type boxes shall be 2.125" minimum depth.
- H. Recessed boxes in ceilings shall be 4" octagonal or square, 2.125" depth.

- I. Recessed boxes in concrete shall be UL approved for the application.
- J. Through-wall type boxes are not acceptable.
- K. Recessed wall telephone and data boxes shall be 4" square, 2.125" deep with single-gang device plaster covers and coverplates.
- L. Provide specially designed boxes where required for special devices.
- M. Boxes containing low voltage and line voltage devices or multiple 277 V switches, supplied from different phases, shall have metal barriers.
- N. Boxes for surface-mounted luminaires shall have fixture studs.
- O. Manufacturer: Appleton, Crouse-Hinds, Hubbell, O-Z/Gedney, Racor, or Thomas & Betts.

2.3 FLOOR BOXES

- A. Boxes in slabs above grade shall be galvanized steel with flush knockouts on sides and bottom.
 - 1. Boxes shall be concretetight and fully adjustable.
 - 2. A leveling plate with screws at each corner shall be factory welded to the bottom for rough leveling. Adjusting rings mounted to the top shall provide a 0.5" vertical or angular adjustment of the top after concrete pour and installation of wiring devices.
- B. Boxes in slabs on grade shall be zinc-coated cast iron with integral threaded conduit openings.
 - 1. Boxes shall be watertight, fully adjustable, and constructed to prevent the entrance of surface and sub-surface water.
 - 2. Boxes shall have a minimum of 2 integral leveling screws for rough leveling. Adjusting rings shall provide a minimum 0.75" vertical or angular adjustment of the top after concrete pour and installation of wiring devices.
- C. Provide a cap to protect the adjusting ring during concrete pour.
- D. Floor plates shall be finish per Architect, configuration as indicated on the Drawings.
- E. Carpet flanges shall be finish per Architect.
- F. Manufacturer: Crouse-Hinds, Hubbell, Thomas & Betts, or Wiremold.

2.4 JUNCTION AND PULL BOXES

- A. Boxes shall be galvanized sheet metal unless otherwise indicated on the Drawings or specified herein, of dimensions required for the number and size of connecting raceways and wiring.
- B. Boxes shall have removable blank covers. Covers on recessed ceiling boxes shall be round. Covers on recessed wall boxes shall be size and finish as used on electrical outlets. Refer to Section 261430, Wiring Devices.
- C. Boxes installed in hazardous locations or corrosive atmospheres, rain or spray, shall be corrosive-resistant cast metal with threaded entrances, removable covers, gaskets and corrosion-resistant hardware.
- D. Manufacturer: Appleton, Crouse-Hinds, O-Z/Gedney, Racor, or Thomas & Betts.

2.5 CONDUIT BODIES

- A. Conduit bodies shall be corrosion resistant cast-metal type, shape and size to suit the location and installation.
- B. Conduit bodies shall have threaded conduit-entrance ends, removable covers, gaskets and corrosion-resistant hardware.
- C. Manufacturer: Appleton, Crouse-Hinds, Hubbell, or O-Z/Gedney.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install boxes at each luminaire, device, and outlet.
- B. Coordinate box installation with wiring or cable and raceways.
- C. Coordinate box installation with other trades so boxes will remain accessible.
- D. Outlet boxes shall not be installed back-to-back. Maintain minimum 24" separation between outlet boxes on opposite sides of rated walls, and minimum 6" separation in nonrated walls.
- E. Install boxes level, plumb, and square to the structure.
- F. Anchor boxes in place. Refer to Section 261900, Supporting Devices.
- G. Provide knockout closures to cap unused open knockout holes.
- H. The approximate locations of outlets are indicated on the Drawings. The exact locations shall be determined at the building. The right is reserved to change the location of any switch, luminaire, or other outlet box in any room before it is permanently installed, without additional cost to the Owner.

3.2 OUTLET BOXES

- A. Install outlet boxes at each electrical, alarm, and signal outlet at heights above the finished floor, measured to the centerline of the outlet, as indicated on the Drawings.
- B. Outlet boxes for flush-mounted devices that are not provided with plaster rings or tile covers shall be set so that the face of the outlet box is recessed 0.125" into the finished wall.
- C. Outlet boxes for flush-mounted devices provided with plaster ring or tile covers shall be set so that the face of the plaster ring/tile cover is recessed 0.125" into the finished wall.
- D. Adjust mounting heights of boxes in masonry walls to minimize cutting and patching of masonry.
- E. Install outlet boxes in one vertical line where indicated adjacent on the Drawings but at different mounting heights.
- F. Wall Telephone and Data Outlets:

1. Install a raceway rising from the top of each outlet box to the ceiling plenum and turn out to an accessible location toward the cable tray. Turn out shall be 12" minimum. Provide a pull line and insulating bushings on both ends of each raceway.
2. Install a single-gang plate mounting bracket in the wall, 0.75" inside diameter grommet in the partition top plate, and a pull line from the wall opening into the ceiling plenum.
3. Install a raceway from each outlet box to the cable tray, backboard or cabinet indicated on the Drawings. Provide a pull line and insulating bushings on both ends of each raceway.
4. Install outlet and pull boxes in accordance with TIA 569-E-2-2019.

3.3 FLOOR BOXES

- A. Install floor boxes according to manufacturer's recommendations.
- B. Complete floor box installation, except for final height adjustment, before concrete pour.
- C. Install carpet flanges for carpet.
- D. Refer to Architectural Drawings for exact locations.

3.4 JUNCTION AND PULL BOXES

- A. Covers on ceiling outlet boxes shall be painted to match the ceiling.
- B. Install exposed junction or pull boxes only in unfinished spaces, unless indicated otherwise on the Drawings.
- C. Do not use pull boxes as turn points.
- D. Junction and pull boxes shall be labeled to identify the feeders and or circuits contained within.

END OF SECTION 261300

SECTION 261430 - WIRING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other electrical systems are specified in other Sections of Division 26.
- B. This Section covers switches, receptacles, device faceplates, weatherproof covers, emergency power off switches, and poke-through fittings.
- C. This Section includes responsibilities and obligations in support of the performance verification specified in Section 260090, Electrical Performance Verification.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. North Carolina State Electrical Code-2018.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Like products shall be by the same manufacturer.
- B. Switches shall comply with UL 20-2018 and Federal Specification W-S-896G-2014.
- C. Receptacles shall comply with UL 498-2017 and Federal Specification W-C-596H-2014.

2.2 TOGGLE SWITCHES

- A. Except as otherwise indicated on the Drawings or specified herein, switches shall be flush type, 120/277 V, 20 A, totally enclosed with toggles colored ivory for use on normal power circuits and red for use on emergency power circuits.
- B. Single-Pole Wall Switches:
 - 1. Manufacturer: Hubbell HBL1221, Leviton 1221-2, or P&S PS20AC1.
- C. Three-Way, Single-Pole, Double-Throw Wall Switches:
 - 1. Manufacturer: Hubbell HBL1223, Leviton 1223-2, or P&S PS20AC3.
- D. Four-Way, Double-Pole, Double-Throw Wall Switches:
 - 1. Manufacturer: Hubbell HBL1224, Leviton 1224-2, or P&S PS20AC4.
- E. Wall switches with pilot lights shall have an LED pilot lamp and red toggle.
 - 1. Manufacturer: Hubbell HBL1221PL, Leviton 1221-PL, or P&S PS20AC1RPL.
- F. Wall switches for projection screen control shall be 3-position, double-pole, double-throw, maintained contact, with positive center off. Switches shall be rated for 20 A at 120 V.

1. Manufacturer: Hubbell HBL1386, Leviton 1286, or P&S 1222.

2.3 RECEPTACLES

- A. Except as otherwise indicated on the Drawings or specified herein, receptacles shall be duplex type, 125 V, with one-piece solid brass mounting strap with rivetless integral ground contacts, colored ivory for use on normal power circuits and red for use on emergency power circuits.
- B. Duplex Receptacles:
 1. Manufacturer, 20 A: Hubbell HBL5362, Leviton 5362, or P&S 5362A.
- C. Ground fault circuit interrupter (GFCI) receptacles shall be UL 943-2016 (R2018) compliant, 20 A, self-testing, tamper resistant, weather resistant, feed-through type.
 1. Manufacturer: Hubbell GFR5362SG, Leviton GFWT2, or P&S 2097TRWR.
- D. USB charger receptacles shall be tamper resistant and shall have 2 Type A, 2.0 USB ports rated 3 A minimum, 5 V DC, compatible with USB 1.1/2.0/3.0 devices, and shall comply with UL 1310-2018.
 1. Manufacturer, 20 A: Hubbell USB20X2, Leviton T5832, or P&S TR5362USB.
- E. Isolated Ground Receptacles, Orange Color:
 1. Manufacturer, 15 A: Hubbell IG5262, Leviton 5262-IG, or P&S IG5262.
 2. Manufacturer, 20 A: Hubbell IG5362, Leviton 5362-IG, or P&S IG5362.
- F. Weather Resistant Receptacles:
 1. Manufacturer, 20 A: Hubbell 5362WR, Leviton TWR20, or P&S WR5362.
- G. Simplex receptacles shall be 20 A.
 1. Manufacturer: Hubbell HBL5361, Leviton 5361, or P&S 5361.

2.4 DEVICE FACEPLATES

- A. Faceplates for flush wall outlets (switch, receptacle, telephone, and signal) shall be type 302 satin finish stainless steel.
- B. Plastic faceplates shall have a smooth surface and be the same color as the device it covers.
- C. Provide a clear extra-strength adhesive-backed tape label with 0.25" high uppercase letters on each receptacle which indicates, as a minimum, the panelboard and circuit number supplying that receptacle. Additional information for specific receptacles shall be provided if indicated on the Drawings.
- D. Manufacturer: Hubbell, Leviton, or P&S.

2.5 WEATHERPROOF COVERS

- A. Weatherproof covers shall be die cast aluminum, designed for wet location protection whether the attachment plug is inserted or removed. Covers shall be NEMA 3R rated when used with the appropriate weatherproof outlet box. Covers shall meet OSHA lockout/tagout requirements.

2.6 EMERGENCY POWER OFF (EPO) SWITCHES

- A. Fully guarded, push button type with 2 normally open momentary contacts.

2.7 POKE-THROUGH FITTINGS

- A. Complete assembly consisting of finished service fitting flush with the floor, fire rated insert containing intumescent organic material, and junction box for connection of power systems below the floor. Where poke-through fittings are used for communication and data cables in conduit located below the floor, those service openings shall be provided with conduit adapters below the floor.
- B. Assemblies shall be UL listed with the utilized quantity and type of power and data conductors.
- C. Flush Fittings:
 - 1. Flush with the floor, with a maximum thickness of 0.625", and with devices as indicated on the Drawings. Fittings shall be 2 hour rated.
 - 2. Carpet flanges shall be die cast aluminum alloy with textured two stage 3 mil thick epoxy paint, or stamped aluminum with anodized finish, color as selected by the Architect.
 - 3. Fire-rated inserts shall have a retainer for securing the device in the slab. Power and communications isolation shall be continued through the device with the power raceway terminating in an accessible junction box below the floor.
 - 4. Where used to provide hard wired connections to furniture or equipment, provide conduit adaptor for connecting each raceway to the furniture or equipment.
 - 5. Manufacturer: Hubbell, Steel City Thomas & Betts, or Wiremold
- D. Additional Fittings:
 - 1. Provide, for future use, extra poke-through fittings in quantity equal to 10% of the quantity of units furnished.
 - 2. Abandonment plugs shall be furnished, for future use, in boxes to the Owner in quantity equal to 10% of the quantity of units furnished. Abandonment plugs shall have the same fire rating as the fittings.

PART 3 - EXECUTION

3.1 GENERAL

- A. Devices shall be installed flush in the wall on which they are located when served by concealed conduit. Where necessary to conceal the conduit or flush mount the device box, masonry or plaster shall be channeled and patched.
- B. Devices shall be surface mounted where their connecting raceways are indicated on the Drawings exposed.
- C. Duplex receptacles shall be 20 A rated.
- D. Receptacle coverplates shall be labeled to indicate panelboard and circuit number supplying them.
- E. Weather resistant receptacles shall be installed in damp or wet locations.
- F. Where 2 or more switches, wall box dimmers, indicating devices, control and communications outlets, or receptacles are indicated on the Drawings at the same location, they shall be ganged and covered with 1 faceplate.

- G. Bond receptacle ground straps to outlet boxes with 6" long green insulated #12 AWG copper jumpers.
- H. Provide an insulated ground from the grounding screw of isolated ground duplex receptacles to the branch circuit panelboard isolated ground bus or the grounding conductor terminal of the applicable derived system.
- I. Install device faceplates and adjust outlets to achieve a flush fit with no gaps.
- J. Vertically mounted receptacles shall be installed with the ground pin up. Horizontally mounted receptacles shall be installed with the ground pin to the left.

3.2 POKE-THROUGH FITTINGS

- A. Install in accordance with the manufacturer's instructions.
- B. Install devices and make connections in the service fittings.
- C. Provide wiring as indicated on the Drawings below the slab and make connections. Extend wiring serving furniture and equipment through the fittings and connect to the furniture or equipment with liquidtight flexible conduit and fittings recommended by the furniture or equipment manufacturer's installation instructions.

END OF SECTION 261430

SECTION 261480 - CONNECTIONS TO MOTORS AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other electrical systems are specified in other Sections of Division 26.
- B. This Section covers connections to electric current consuming equipment, and includes installation and connection of associated control devices in the power circuit.
- C. This Section includes responsibilities and obligations in support of the performance verification specified in Section 260090, Electrical Performance Verification.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. NECA 230-2016.
 - 2. North Carolina State Electrical Code-2018.

1.3 EQUIPMENT LOCATIONS

- A. Locations of motors, starters, equipment and apparatus as indicated on the Drawings are approximate; connections shall be made to such equipment as actually installed.
- B. Coordinate the locations of starters or other control devices with the equipment being controlled in accordance with local code requirements. The installed location of motors, equipment, and associated ductwork shall be considered to ensure clearance, access, and sight requirements.

1.4 RELATED WORK DESCRIBED IN OTHER DIVISIONS

- A. Refer to other Divisions of these specifications for equipment requiring electrical connections.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. See other Sections of Division 26 for materials and equipment.

PART 3 - EXECUTION

3.1 WIRING

- A. Provide power wiring to equipment requiring electrical power specified in all Divisions of these specifications. Power wiring is defined as wiring in the electrical circuit between the source of power and the current consuming device, and includes the mounting and installation of starters, variable frequency drives and associated DV/DT output filters, and other control devices and interlock contacts controlling loads for which no magnetic starter or contactor is provided.

- B. Provide control wiring to equipment requiring electrical control specified in all Divisions of these specifications. Refer to Divisions 21, 22, and 23 for control wiring provided under each Division.
- C. Make final connections to equipment such that loads are balanced across phases in branch circuits, feeders, and panelboards. Where multiple units are connected to the same branch circuit or feeder, packaged equipment incorporating both single phase and three phase loads shall be connected such that the single phase loads are balanced as closely as possible across the phases of the three phase branch circuit or feeder serving the equipment.

END OF SECTION 261480

SECTION 261700 - CIRCUIT AND MOTOR DISCONNECTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other electrical systems are specified in other Sections of Division 26.
- B. This Section covers circuit and motor disconnects.
- C. Disconnects provided with mechanical equipment are specified in Division 23.
- D. Refer to Section 264750, Overcurrent Protective Devices, for fuses.
- E. This Section includes responsibilities and obligations in support of the performance verification specified in Section 260090, Electrical Performance Verification, and commissioning specified in Section_____.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. North Carolina State Electrical Code-2017.

PART 2 - PRODUCTS

2.1 ENCLOSURES

- A. Enclosures shall be surface mounted, unless indicated otherwise on the Drawings.
- B. Type of enclosures specified herein or indicated on the Drawings refer to NEMA types as defined in NEMA 250-2018.
- C. Enclosures shall be NEMA 1 in dry locations and NEMA 3R where exposed to rain or spray, unless indicated otherwise on the Drawings. Disconnects installed in hazardous locations or corrosive atmospheres shall be UL listed for the specific application.

2.2 DISCONNECT SWITCHES

- A. Switches shall have ground and insulated neutral lugs where ground and neutral conductors are provided in the circuit.
- B. Where installed ahead of elevator drives and between variable frequency drives and motors, provide electrical interlock kits to break the control circuit before the main switch blades open. Control contacts shall be one normally open and one normally closed, 120 V AC, 15 A rating.
- C. Switches shall be heavy duty, motor rated, 600 V, with capacity and number of poles indicated on the Drawings. Fuse holders shall be designed to receive Class R fuses unless otherwise indicated on the Drawings.
- D. Manufacturer: Eaton DH, GE TH, Siemens H, or Square D Class 3110.

- E. Nonfusible type for motor loads 2 hp or smaller or nonmotor loads connected to a 20 A or smaller circuit may be toggle type switches, or nonautomatic circuit breakers, UL listed for each specific type load.
 - 1. Manufacturer: Crouse-Hinds, GE, Leviton, Square D, or Westinghouse.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Disconnects shall be installed where specified herein, indicated on the Drawings, or required by manufacturer's written instructions.
- B. Install combination disconnect/motor starters furnished under other Divisions.
- C. Provide control wiring for electrical interlocks between elevator drives and motor disconnects.
- D. Provide control wiring for electrical interlocks between drives and variable frequency motor disconnect switches.
- E. Coordinate disconnect installation with raceways, wiring, and equipment.
- F. Anchor disconnects. Refer to Section 261900, Supporting Devices for specific requirements.

3.2 LOCATION

- A. Coordinate location of disconnects with equipment being controlled.
- B. When used as disconnecting means, locate as near as practicable to the load controlled.
- C. When used for branch circuit protection, disconnects shall be located as near as practicable to the supply end of the conductors being protected.
- D. Disconnects used with motor-driven appliances, or motors and controllers shall be located within sight of controller, unless indicated otherwise on the Drawings.
- E. Disconnects shall be installed in accessible locations.

3.3 FUSIBLE DISCONNECTS

- A. Fusible disconnects shall not be mounted in ceiling plenums.
- B. Fuses shall be installed in fusible disconnects as specified in Section 264750, Overcurrent Protective Devices.

END OF SECTION 261700

SECTION 261900 - SUPPORTING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other electrical systems are specified in other Sections of Division 26.
- B. This Section covers supporting devices.
- C. This Section includes responsibilities and obligations in support of the performance verification specified in Section 260090, Electrical Performance Verification.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. North Carolina State Electrical Code-2018.

PART 2 - PRODUCTS

2.1 BEAM CLAMPS

- A. Galvanized steel, with tapped holes in base and face for bolts or hanger rods.
- B. Manufacturer: Appleton, Efcor, or Kindorf.

2.2 CABLE TIES

- A. One-piece, nylon, with a 90° insertion angle.
- B. Manufacturer: 3M, Ideal Industries, Panduit, or Thomas & Betts.

2.3 CONDUIT SUPPORTS

- A. Galvanized steel straps or hangers, or spring steel type hangers or clamps.
- B. Manufacturer: Appleton, Caddy, Raco, or Thomas & Betts.

2.4 CABLE SUPPORTS

- A. Galvanized malleable iron with multiple segment plugs.
- B. Manufacturer: Appleton, Crouse-Hinds, or O-Z/Gedney.

2.5 CHANNEL STRUT SYSTEMS

- A. Galvanized steel, 14 gauge minimum, with factory-punched attachment holes. Straps for the support of conduit shall be designed so that the attachment nut is captive on the shoulder of the strap when tightened. Attachment nuts shall be designed to provide a surface on the turned down edge while making positive

contact with the side walls of the channel. Nuts, bolts, straps, and accessories shall be protected with same finish as channels.

- B. Manufacturer: B-Line Systems, Kindorf, Midland-Ross, or Unistrut.

2.6 WOOD BACKBOARDS

- A. Exterior grade, 0.75" thick, B-C UL listed fire-resistant plywood tested in accordance with UL 723-2018 Category BUGV. Flame spread rating shall be 25 or less.

PART 3 - EXECUTION

3.1 GENERAL

- A. Anchor or support raceways, cables, and electrical equipment as specified herein.

3.2 BEAM CLAMPS

- A. Beam clamps may be used for support of raceways, enclosures, panelboards or equipment where attached to or from fixed steel supports or structures. Beam clamps fastened to steel supports not horizontal or vertical shall be provided with a swing connector. Beam clamps fastened to structures in a horizontal position (where bolt is horizontal) shall not be used for support of equipment exceeding 10 lb.

3.3 CABLE TIES

- A. Cable ties shall be provided for securing, grouping and organizing conductors or cables in panelboards, switchboards, wireways, or enclosures.

3.4 CABLE SUPPORTS

- A. Install cable supports in vertical runs at intervals required by codes.

3.5 CHANNEL STRUT SYSTEMS

- A. Use channel strut systems for support of multiple runs of conduit, enclosures, panelboards, and equipment.
- B. Support channel strut from minimum 0.375" steel rods when not directly fastened to structure.

3.6 CONDUIT SUPPORTS

- A. Use straps, clamps, or hangers to support individual runs of conduit.
- B. Spring steel hangers or clamps may be used to support conduit from steel except where exposed to rain or moisture.
- C. Secure conduit support devices to structure with wood screws on wood, toggle bolts on hollow masonry, lead anchors on solid masonry or concrete, and machine bolts and beam clamps on steel. Threaded studs driven in by a powder charge and provided with lock washers and nuts may be used in lieu of lead anchors where approved by the Architect.

- D. Support conduits, secured to surfaces exposed to water or spray, by straps or hangers, utilizing clamp backs or spacers made for the purpose which hold conduit off surface.
- E. Conduits shall not be supported from ceiling suspension systems.
- F. Conduit supports shall not be welded to steel structures.
- G. Install riser clamps for vertical conduits as required by codes.

3.7 WOOD BACKBOARDS

- A. Install wood backboards where 2 or more disconnect switches, individual circuit breakers, or equipment are installed, and where indicated on the Drawings or specified herein.
- B. Anchor wood backboards to walls with lag bolts on wood, toggle bolts on drywall or hollow masonry, and lead anchors on solid masonry or concrete.
- C. Paint backboards with 2 coats of fire-inhibiting gray enamel on both sides and all 4 edges before installation of equipment.
- D. Backboards installed on walls in telephone/data rooms or walls dedicated to communications equipment shall be 8' high minimum, unless indicated otherwise on the Drawings. Lower edge of 8' backboards shall be set at floor level. Width shall be as indicated on the Drawings.
- E. Coordinate size of backboards for other equipment with equipment mounted thereon.

END OF SECTION 261900

SECTION 262000 - EMERGENCY POWER SUPPLY SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other electrical systems are specified in other Sections of Division 26.
- B. This Section covers the emergency power supply system, including engine-generator sets, each with controls and control panel, remote alarm annunciator, generator docking stations, paralleling and control equipment, automatic transfer systems, and accessories to automatically parallel and supply power during a utility power failure.
- C. Emergency power supply system installation and performance shall meet NFPA 110-2019, Level 1, Type 10 applications.
- D. Vibration isolation is specified in Section 260010, Electrical General.
- E. This Section includes responsibilities and obligations in support of the performance verification specified in Section 260090, Electrical Performance Verification.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. 40 CFR 63 Subpart ZZZZ-2018.
 - 2. NECA/EGSA 404-2014.
 - 3. UL 2200-2012.
 - 4. North Carolina State Electrical Code-2018.

1.3 RECORD DRAWINGS

- A. In addition to the requirements specified in Section 260010, Electrical General, include:
 - 1. Equipment outlines, showing front and side plan views, electrical power one-line diagram, and equipment ratings.
 - 2. Schematic drawings.
 - 3. Wiring diagrams.
 - 4. Interconnection wiring diagram, showing field interconnections between engine-generator sets, switchboards, automatic transfer switch systems, annunciators, and day tanks.
 - 5. Material lists, cross referenced to schematics for component identification.
 - 6. Narrative sequence of operation description, detailing operating modes.
 - 7. Ladder diagram and program listing for programmable controller with each logic rung's purpose clearly defined, including identification of inputs and outputs.
 - 8. Generator decrement curve, damage curve, and available fault current at the generator terminals.
- B. Equipment drawings shall specifically show the interface between the paralleling controls and remote devices.

1.4 SERVICE

- A. Manufacturer shall maintain a local parts and service facility, within 50 miles of this Project, which shall have inventory to cover not less than 80% parts service within 24 hours and 95% within 48 hours. Further,

the facility shall have a factory-trained service representative to furnish installation, test, and start-up supervision necessary for final approval and acceptance, as well as to perform maintenance, oil sample analysis, and repairs on components.

1.5 SERVICE CONTRACT

- A. Make available to the Owner a service contract which, as an option, may be accepted. The contract shall be for the complete services rendered over a period of 1 year beginning at completion of the Contractor's 1 year warranty, and shall include, but not be limited to, the following:
1. Manufacturer's recommended procedures for weekly inspection and maintenance.
 2. Quarterly inspection to review the weekly maintenance records being kept by the Owner and train any new operating personnel. Inspection shall include scheduled oil sampling. A system load test shall be included.
 3. Annual inspection shall include the above items except that the engine-generator sets shall be run under 100% load. Provide load banks, electrical connections, and fuel for these tests. Test shall be for minimum of 4 hours.
 4. Work shall be done during normal business hours. Should any work, by its nature, be required to be performed after business hours, the Owner shall be responsible for any overtime charges. Provide a written estimate of any potential overtime charges and obtain written prior approval before proceeding.
- B. WARRANTY: In addition to other warranties specified herein, equipment shall be guaranteed against defective parts and workmanship under terms of the manufacturer's standard warranty for a period of not less than 5 years from date of initial start-up of the system and shall include parts, labor, and travel time.

PART 2 - PRODUCTS

2.1 GENERAL

2.2 SEQUENCE OF OPERATION

- A. Loss of normal power: upon receipt of a signal to start from automatic transfer switches, manual control, or other remote device, engine-generator sets shall automatically and independently start, accelerate to rated frequency and build up to rated voltage. The first start system shall monitor this process, and on finding an engine-generator set at 90% of rated voltage and frequency, shall automatically disable other units from closing to the bus, and shall close the ready unit to the bus. At this time first priority transfer switches shall begin the time delay transfer sequence, and on completion transfer their loads to the system bus.
1. The priority controls shall prevent overloading of the system bus by providing inhibit signals to prevent transfer of selected loads to the emergency system until sufficient generating capacity is available on the bus, or until the priority override switch is actuated.
 2. After the first unit is closed to the bus, the control of the remaining units shall be switched to the synchronizer in each paralleling control, which shall cause the engine-generator set to synchronize with the system bus, and then close to it at the proper time.
 3. As each unit closes to the bus, the unit shall assume its proportional share of the total load on the bus.
- B. Failure of a unit to start or synchronize: if a unit fails to start, after the overcrank time delay in the engine-generator set control has expired, the unit shall be shut down, and an alarm shall sound. The priority control shall prevent the lowest priority loads from being added to the system without manual intervention. The priority override key switches shall allow low priority loads to be manually added to the bus. Bus overload monitoring shall protect the first priority loads in the event that the bus is inadvertently overloaded.

1. If a unit fails to synchronize, after a preset time delay, an alarm shall sound, but the unit shall continue to attempt to synchronize until signalled to stop, by manual operation of system control switches.
- C. Bus overload: if a bus overload occurs for any reason, a load shed signal shall be generated to initiate load shedding in the system.
 1. If the bus does not return to proper frequency within a predetermined period of time, additional load shed signals shall be generated.
- D. Load demand mode: when the system is running in the emergency mode with the load demand switch in the on position, controls shall continuously monitor the total load on the bus. If the total load on the bus falls below preset limits for a period of 15 minutes, the controller shall automatically shut down engine-generator sets in an operator predetermined order, until the minimum number of engine-generator sets required to safely handle the load remain on the bus.
 1. On sensing that the available bus capacity is being approached, the standby units shall automatically be restarted, in the reverse order of which they were shut down, and paralleled with the bus to assume their proportional share of system load.

2.3 ENGINE-GENERATOR SETS

A. General:

1. Engine-generator sets shall be factory assembled and tested, and shall be mounted on a structural steel frame with vibration isolators.
2. Power rating: engine-generator sets shall have standby rating. Rating shall be based on operation at rated rpm when equipped with operating accessories, including air cleaners, lubricating oil pump, fuel transfer pump, fuel injection pumps, jacket water pump, governor, alternating current generator, radiator fan, and exciter regulator.

B. Exterior Enclosures:

1. Metal non walk-in weatherproof type. Enclosures shall be factory assembled and wired, and shall have the following features:
 - a. AC load center, 100 A minimum, with an individual circuit for each AC load inside the enclosure.
 - b. A minimum of 2 each interior luminaires and convenience receptacles. Luminaires shall be vaportight LED.
 - c. Personnel doors, minimum 2. Doors shall be fully gasketed with forged aluminum hinges with stainless steel pins and nylon bushings. Doors shall have stainless steel handles, padlock provisions, plated 3-point locking mechanisms, and panic bar interior openers.
 - d. Exterior steps shall be provided to personnel doors where bottom of door is 18" or higher above finished grade.
 - e. Interior walls and ceiling covered with acoustical material, finished with mill finished perforated aluminum panels.
 - f. Stainless steel bird screens on exterior openings.
 - g. Lifting eyes, maximum 6.
 - h. Minimum of 1 dry-type fire extinguisher.
 - i. Enclosures shall consist of a roof, 2 sidewalls, and 2 end walls of prepainted aluminum stressed-skin monocoque construction and shall include provisions for an internally mounted exhaust silencer. Exterior finish shall be prepainted aluminum with color selected by the Architect.
 - j. Intake and discharge louvers shall be constructed of aluminum and shall be sized to allow full load operation of the engine-generator set at specified site conditions without deration.
 - k. Manufacturer: same as engine-generator set manufacturer, or Altorfer Power Systems, Chillicothe Metal Company, or Pritchard-Brown.

C. Diesel Engines:

1. Water-cooled, inline or vee compression diesel type designed to operate on No. 2 fuel oil.
2. Engines shall be equipped with flexible fuel connections, fuel, lube oil, and intake air filters, crankcase emission filtration system, lube oil cooler, fuel transfer pump, hand fuel priming pump, service meter, gear-driven water pump, and instruments, including a fuel pressure gauge, water temperature gauge, and lubricating oil pressure gauge. Engines shall be designed and equipped to return unburned fuel to the day tank. Engine cooling system shall be pretreated to prevent internal corrosion.
3. Governors: shall maintain isochronous frequency regulation from no load to full rated load. Steady state operating band shall be $\pm 0.25\%$. Governors shall include provisions for remote speed adjustment, and shall include load share provisions for paralleling with present and future units.
4. Protective devices:
 - a. Safety shutoffs shall include high water temperature, low oil pressure, electrical overspeed, low fuel, and engine overcrank.
5. Radiators:
 - a. Engine-mounted, with fan, designed for operation at ambient temperature of 110°F.
6. Silencers: cylindrical style selected with companion flanges equal or greater in size to the connecting pipe, and flexible stainless steel bellows-type exhaust wye connector and fittings as required. Silencers shall be sized such that the maximum allowable backpressure for the engine-generator set is not exceeded as installed, including exhaust piping upstream of silencer, wye fitting, a silencer, and exhaust piping downstream of silencer. Silencers shall be _____ grade and have a minimum noise reduction of 33 dBA.
7. Automatic Starting System:
 - a. Starting motors: 24 V electric starting system with positive engagement drive and capacity to crank the engine at a speed which shall start the engine under operating conditions. Starting pinion shall disengage automatically when the engine starts. Starting system shall incorporate an automatically reset circuit breaker for anti-ratchet engagement.
 - b. Automatic controls: fully automatic start-stop controls shall be provided in the control panel. Controls shall include one 45 s continuous cranking cycle with lockout and manual reset feature. Provide for automatic paralleling controls and annunciation.
 - c. Jacket water heaters: 2 engine-mounted thermal circulation tank-type immersion water heaters incorporating an adjustable thermostatic switch shall be furnished to maintain engine jacket water at 90°F in a still air ambient temperature of 10 °F. Heaters shall be 208 V, 1-phase, 60 Hz each.
 - d. Batteries and Battery Chargers:
 - 1) Batteries shall be lead-acid storage type. Battery set shall be rated by the battery manufacturer in accordance with requirements of engine manufacturer. Battery rack, cables, and clamps shall be provided. Batteries shall be capable of cranking the engine for 45 seconds at 32°F.
 - 2) Chargers shall use transistor-controlled magnetic amplifier circuits to provide continuous taper charging and shall maintain rated output voltage within $\pm 1\%$ from no load to full rated load. Chargers shall be the dual rate type (float and equalize) with a minimum rating of 10 A. Chargers shall be furnished in a NEMA 1 enclosure with a DC ammeter and DC voltmeter, and shall include malfunction alarm contacts for use in conjunction with remote annunciator.
8. Oil sample analysis kit: shall include 1 sample extraction gun, 10 bottles, 10 postage paid mailers, and instructions.

D. Controls:

1. Control Panel:

- a. A control panel shall be provided and shall contain the following devices and provide the following functions:
 - 1) A control switch labeled Automatic-Off-Run to perform the following functions:
 - a) Automatic: start and stop the engine-generator set automatically by the closing and opening of a remote contact.
 - b) Off: stop the engine-generator set.
 - c) Run: manually start and run the engine-generator set.
 - b. Separate visual indication and common audible alarm shall be provided for:
 - 1) Overcrank.
 - 2) Low coolant level.
 - 3) Low coolant temperature.
 - 4) Anticipatory high coolant temperature.
 - 5) High coolant temperature.
 - 6) Anticipatory low oil pressure.
 - 7) Low oil pressure.
 - 8) Overspeed.
 - 9) Low fuel.
 - 10) Control switch not in automatic position.
 - 11) Contacts for local and remote common alarm.
 - 12) Air shutdown damper (when used).
 - c. Separate visual indication shall be provided for:
 - 1) Generator supplying load.
 - 2) Utility supplying load.
 - 3) Low battery voltage.
 - 4) High battery voltage.
 - 5) Battery charger AC failure.
 - d. Switches shall be provided for:
 - 1) Alarm silence.
 - 2) Lamp test.
 - 3) Emergency stop.
 - 4) Start engine.
 - 5) Transfer load.
 - e. Controls shall shut down and lock out the engine-generator set under the following conditions:
 - 1) Overcrank.
 - 2) Overspeed.
 - 3) Low oil pressure.
 - 4) High coolant temperature.
 - 5) Air shutdown damper (when used).
 - 6) Remote emergency stop.
 - 7) Low coolant level.
 - f. A clock exerciser shall be provided in the control panel.
2. Remote Alarm Annunciator:
- a. A battery-powered remote annunciator shall be provided to operate outside of the generator room at the location indicated on the Drawings. The annunciator shall indicate the alarm condition of the engine-generator set as follows:
 - 1) Individual visual signals shall indicate:
 - a) Generator supplying load.

- b) Utility supplying load.
 - c) Battery charger malfunctioning.
 - 2) Individual visual signals plus a common audible signal shall warn:
 - a) Low oil pressure.
 - b) Low water temperature.
 - c) High water temperature.
 - d) Low fuel main tank.
 - e) Overcrank.
 - f) Overspeed.
 - g) Ground fault indication.
 - h) Remote emergency shutdown.
 - 3) Switches shall be provided for:
 - a) Lamp test.
 - b) Alarm silence.
- 3. Remote Emergency Manual Stop Station:
 - a. Provide a remote manual stop pushbutton station in weatherproof enclosure with lift cover and audible and silent remote alarm signal to the remote alarm annunciator panel when the lift cover is raised for engine-generator set shutdown.
 - b. Manufacturer: Eaton, Pilla, or Square D.

E. Generators:

- 1. Type: 3-phase, single-bearing, synchronous type, wet wound, tropicalized, and shall comply with NEMA MG 1-2016, Part 22. Class H insulation shall be used on the stator and rotor, and both shall be further protected with an asphalt modified epoxy on end coils. Generators shall incorporate reactive droop compensation for parallel operation with future unit, and shall also include a resettable thermal protector and fuse for exciter/regulator protection against extended low power factor loads and faults. Provide paralleling suppressors for protection of generator excitation system. Generator rotors shall be dynamically balanced within 0.0005" peak-to-peak amplitude displacement at both ends of shafts and shall sustain 25% overspeed.
- 2. Regulators: 3-phase sensing RMS voltage regulators, automatic volts-per-hertz type, solid state exciter/regulator, shock-mounted inside generator. Voltage regulation shall be $\pm 1\%$ from no load to full rated load. Accessible voltage drop, voltage level, and voltage gain controls shall be included in the module. Voltage level adjustment shall be a minimum of $\pm 10\%$. Provide cross-current compensation circuit with on/off switch. Modules shall include the following protective features:
 - a. Current limit circuits shall restrain the exciter field current while allowing full forcing voltage to be applied to obtain rapid response during transient conditions or service overloading on the generator.
 - b. A time delay circuit shall sense the current limit operation and interrupt field current to the generator after 10 s.
 - c. Loss of field monitoring.
- 3. Devices:
 - a. 3.5", 90° scale, 2% accuracy instruments:
 - 1) Ammeter.
 - 2) Voltmeter.
 - 3) Frequency meter.
 - 4) Wattmeter.
 - b. Running time meter.
 - c. Heavy duty meter control switches for:

- 1) Voltmeter, 7-position.
 - 2) Ammeter.
 4. Permanent magnet pilot excitor: generators shall incorporate a permanent magnet pilot excitor feature to provide isolation of the excitor from the generator stator windings to prevent irregularities of voltage wave form caused by load conditions. Permanent magnet pilot excitor shall also provide for a minimum of 300% rated current for 10 seconds during short circuit conditions for selective tripping of downline protection devices on a load short circuit.
 5. Provide a unit-mounted circuit breaker.
 - a. Breaker shall be equipped with an electronic trip unit with the following front panel adjustments:
 - 1) Long time pick-up.
 - 2) Long time delay.
 - 3) Short time pick-up.
 - 4) Short time delay.
 - 5) Instantaneous pick-up.
 - 6) Energy reducing maintenance switch if 1,200 A or larger.
 - 7) Ground fault alarm.
- F. Factory Tests:
 1. Engine-generator sets shall be factory tested before shipment. Tests shall be as follows:
 - a. Warm-up and Adjustments:
 - 1) Warm-up at synchronous speed with 1.0 power factor electrical load.
 - 2) Final high idle speed adjustment, voltage level adjustment, and voltage gain adjustments.
 - 3) After adjustments, the following shall be recorded:
 - a) Generator speed.
 - b) Frequency.
 - c) Power.
 - d) Line-to-line voltages.
 - e) Average voltage.
 - f) Frequency stability.
 - g) Voltage stability.
 - h) Overshoot.
 - i) Fan power.
 - j) Engine-generator set efficiency at test speed and 1.0 power factor, fuel density, inlet air temperature, inlet air pressure, inlet air restriction, fuel temperature in injection pump housing, and total running time.
 - b. Subject unit to a sequence of load changes up to and including full load to determine transient response characteristics as follows:
 - 1) Voltage dip - percent of instantaneous voltage drop on addition of load.
 - 2) Voltage overshoot - percent of instantaneous voltage rise on subtraction of load.
 - 3) Frequency dip - percent of instantaneous frequency drop on addition of load.
 - 4) Frequency overshoot - percent of instantaneous frequency rise on subtraction of load.
 - 5) Recovery time - time necessary to achieve steady state voltage and frequency after sudden additions or subtractions of load.
 2. Upon completion of the tests, the manufacturer shall submit 6 sets of the certified test reports demonstrating test procedure compliance and data recorded. In addition, an oil sample shall be taken during the test at full and partial load, then laboratory analyzed for signs of unusual wear. Testing shall be performed on the actual serial number units assigned for delivery to this Project.
- G. Manufacturer: Caterpillar, Cummins-Onan, or Kohler.

2.4 PARALLELING AND CONTROL EQUIPMENT

- A. Paralleling and control equipment shall automatically start, synchronize, and place in operation the 2 engine-generator sets, and control the loading of those sets as specified herein.
- B. Paralleling Control Panels:
1. A paralleling control panel shall be provided for each engine-generator set. Panels shall contain the following components and devices:
 - a. Front Panel Devices:
 - 1) 3.5", 90° scale, 2% accuracy instruments:
 - a) Ammeter.
 - b) Voltmeter.
 - c) Frequency meter.
 - d) Wattmeter.
 - b. Running time meter.
 - c. Heavy duty meter control switches for:
 - 1) Voltmeter, 7-position.
 - 2) Ammeter.
 - d. Automatic-off-run selector switch. Functions of this switch shall be coordinated with the engine-generator set control switches mounted on the set to provide the following functions:
 - 1) Emergency stop.
 - 2) Automatic starting, controlled by paralleling system.
 - 3) Manual starting/paralleling.
 - 4) Inhibit starting of the engine-generator set.
 - 5) Manual starting of the engine-generator set.
 - e. Breaker trip/close push button switches. Manual breaker closing shall not be possible unless the synchronizing lamps are on and manual mode permissive relay is utilized.
 - f. Lighted control reset push button switch.
 - g. Lamp test push button switch.
 - h. Synchronizing lamps with on/off switch. Synchronizing lamps shall be minimum 1.5" diameter with clear bulbs and visible filaments.
 - i. Locking, 10 turn, voltage and frequency adjust pots.
 - j. Oiltight individual alarm lamps, minimum 1" diameter, and a common audible alarm shall be provided for:

<u>Function</u>	<u>Alarm Lamps</u>	<u>Audible Alarm</u>	<u>Shutdown Unit</u>
Failure to synchronize	amber	*	
Low oil pressure	amber	*	
Low fuel-daytank	amber	*	
Low engine temperature	amber	*	
High engine temperature	amber	*	
Not in automatic	red	*	
High engine temperature	red	*	*
Low oil pressure	red	*	*
Overcurrent	red	*	*
Loss of field	red	*	*
Reverse power	red	*	*
Overcrank	red	*	*
Overspeed	red	*	*
Breaker closed	red		

<u>Function</u>	<u>Alarm Lamps</u>	<u>Audible Alarm</u>	<u>Shutdown Unit</u>
Control lockout	red	*	
Low coolant level	red	*	*
Overvoltage	red	*	*
Automatic mode	green		
Breaker open	green		
Engine-generator set running	green		
Demand mode standby	green		
Cool down mode	green		

2. Control devices shall be industrial type oiltight with contact ratings a minimum of twice the maximum circuit ampacity they are controlling. Indicator lamps shall be changed from the front of the panel, without requiring the removal of the lamp holder or any wiring. Indicator lamp condition (on or off) shall be visible in bright room lighting conditions.
3. Control panels shall contain the following internal controls:
 - a. Electrically operated power circuit breaker with electronic trip unit (long, short, and instantaneous trips) and under voltage release. Size shall be as indicated on the Drawings.
 - 1) The electronic trip unit shall provide the following front panel adjustments:
 - a) Long time pick-up.
 - b) Long time delay.
 - c) Short time pick-up.
 - d) Short time delay.
 - e) Instantaneous pick-up.
 - f) Ground fault pick-up.
 - g) Ground fault delay.
 - h) Ground fault alarm.
 - 2) Manufacturer: GE, or Westinghouse.
 - b. Electronic isochronous load sharing module for controlling the engine governors during synchronizing and to provide isochronous load sharing. The isochronous load sharing module and engine governor shall be a coordinated system of a single manufacturer.
 - c. First start sensor with automatic mode permissive relay to connect first engine-generator set to reach approximately 90% of rated frequency and voltage to the emergency bus. The first start sensor for each engine-generator set shall be solid state and be sequentially enabled. The first start sensor shall positively prevent out-of-phase paralleling if 2 or more engine-generator sets reach operating conditions simultaneously and shall include redundant circuitry to ensure operation, even if the primary system is disabled. System shall include controls to recognize the failure of the first breaker signalled to close, and allow system operation to proceed despite this failure.
 - d. Synchronizer to electronically adjust the engine governor to match the frequency and phase angle of the bus. Synchronizer shall maintain the engine-generator set frequency within 20 electrical degrees of the bus for 0.5 s before circuit breaker closing. Each unit shall have its own synchronizer.
 - e. Automatic mode permissive relay, used in conjunction with the synchronizer to assure that the breaker for the generator does not attempt to close out of phase with the bus, due to errant operation of the synchronizer.
 - f. Separate mode permissive relay, to be used with synchronizing lamps during manual paralleling, to prevent accidental closure of the breaker with the generator out of phase with the bus.
 - g. Control modules shall contain a system of diagnostic LEDs to assist in analyzing proper system function, consisting of: first on line; in phase; emergency bus on; engine-generator set on; synchronizer on; and dead bus mode.

- h. Electronic reverse power relay to sense reverse power flow through the generator paralleling circuit breaker. When the reverse power condition exceeds a preset level, adjustable from 2% to 20% of the generator's full power rating, for a given time period, adjustable from 0.4 s to 20 s, the circuit breaker shall be tripped open and the engine-generator set shut down.
- i. Pulse alarm system to sound alarm at first fault and at each subsequent fault.
- j. Engine-generator set start contacts.
- k. Cooldown time delay, adjustable: 1 min to 15 min.

C. Master Controls:

1. Master, totalizing controls shall monitor and control the operation of the paralleling system. The master panel shall include:
 - a. A front panel, including:
 - 1) Heavy duty key switches for the following functions:
 - a) Load restore.
 - b) Load pick-up, priority override, 1 per level.
 - c) Load demand mode on/off.
 - 2) Underfrequency reset push button switch.
 - 3) Alarm silence push button switch.
 - 4) 3.5", 90° scale, 2% accuracy instruments:
 - a) Ammeter.
 - b) Voltmeter.
 - c) Wattmeter.
 - 5) Heavy duty metal control switches for:
 - a) Voltmeter, 7-position.
 - b) Ammeter.
 - c) Manufacturer: Electroschalt 24 series.
 - 6) Demand mode sequence selector switch.
 - a) Manufacturer: Electroschalt 24 series.
 - 7) Alarm horn.
 - 8) System test system.
 - a) Manufacturer: Electroschalt 24 series.
 - 9) Oiltight individual alarm lamps, minimum 1" diameter, and a common audible alarm shall be provided for:

<u>Function</u>	<u>Alarm Lamps</u>	<u>Audible Alarm</u>
System test	green	
Load demand mode	green	
Priority load pick-up	green	
Load shed	red	*
Utility power failure	red	
Bus underfrequency	red	*

2. Control devices shall be industrial type, oiltight with contact ratings a minimum of twice the maximum circuit ampacity they are controlling. Indicator lamps shall be changed from the front of the panel, without requiring the removal of the lamp holder or any wiring. Indicator lamp condition (on or off) shall be visible in bright room lighting conditions.
3. Internal Controls:
 - a. Programmable controller for load demand, load pick-up, and load shed functions.

- b. 2 level load pick-up output contacts, rated 10 A, 600 V (3 contacts per level).
 - c. 2 level load shed output contacts, rated 10 A, 600 V (3 contacts per level).
 - d. Electronic underfrequency relay with time delay.
 - e. Time delay start, adjustable: 0 s to 15 s.
- D. Manufacturer: same as the manufacturer of the engine-generator sets,. Automatic transfer switch or switchgear supplier shall work under contract to the engine-generator set manufacturer who shall have sole source responsibility for their work.

2.5 AUTOMATIC TRANSFER SWITCH SYSTEMS

A. General:

1. Each system shall be the product of one manufacturer. Automatic transfer switches shall include a 2-way bypass isolation switch where indicated on the Drawings. Automatic transfer switches shall be closed-transition type where indicated on the Drawings. Each system shall comply with NEMA ICS 10-2005 Part 4 and UL 1008-2014, and shall be rated for total system load.
2. Construction: each system shall be supplied completely assembled in a NEMA 1 enclosure. Systems shall be completely factory assembled and tested prior to shipment. Power interconnections shall be silver-plated copper bus bar. Control interwiring shall be provided with disconnect plugs. A visual position indicator shall be provided to indicate bypass-isolation switch position. Pilot lights shall indicate availability of power sources and automatic transfer switch position. Switches shall include a detailed instruction plate.
3. Performance: switch performance shall meet or exceed the following requirements and, if so requested by the Architect, be verified by certified laboratory test data.
 - a. Temperature rise: measurements shall be made after the overload and endurance tests.
 - b. Withstand and closing ratings: rated to withstand the available RMS symmetrical short circuit current at the switch terminals with the upstream over-current protection. When protected by molded case circuit breakers, switches shall have the following minimum withstand and closing ratings:

<u>Ampere Size</u>	<u>Symmetrical Amperes RMS at 480 V AC</u>
30	10000
70-150	22000
260-400	42000
600-800	65000
1000-1200	85000
1600-4000	100000

- c. Dielectric: measurements shall be made at 1960 V RMS minimum following the withstand current rating test.
 - d. Transient withstand: control panel shall pass the voltage surge withstand test per IEEE C37.90.1-2012 and the voltage impulse withstand test per NEMA ICS 1-2000 (R2005, R2008, R2015).
- 4. Manufacturer, automatic transfer switches: ASCO 7000 series, Russelectric RMT, or Zenith ZTS.
- 5. Manufacturer, automatic transfer and bypass switches: same as the manufacturer of the engine-generator set or ASCO 7000 series, Russelectric RTB, or Zenith ZBTS.

B. Automatic Transfer Switches:

1. Electrical operation shall be accomplished by a momentarily energized solenoid operating mechanism which receives power from the source to which the load is being transferred. Operating transfer time shall be a maximum 0.17 s. Each position shall be mechanically locked.

2. Operation shall be inherently double-throw whereby contacts move simultaneously and with no programmed delay in a neutral position. An overload or short circuit shall not cause the switch to go to a neutral position.
3. Inspection of contacts, movable and stationary, shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. A manual operating handle shall be provided for maintenance purposes. The maintenance handle shall permit the operator to stop the contacts at any point throughout the entire travel to inspect and service the contacts.
4. Switches shall have switched neutrals and shall have fully rated neutral transfer contacts which shall momentarily interconnect the neutrals of the sources and load during the transfer/retransfer operation.
5. Automatic transfer switches shall include separately mounted control panels with adjustable solid state sensing and timing functions, and the following operational characteristics:
 - a. Time delay on momentary dips in normal source (0.5 s to 6 s) factory set at 1 s delay in transfer switch and engine starting signals.
 - b. Time delay on transfer to emergency for controlled loading for generator (0 min to 1 min), factory set at 0 min.
 - c. Time delay on retransfer to normal (0 min to 30 min), factory set at 15 min. Automatic bypass if emergency source fails and normal source is available.
 - d. Toggle switch to manually bypass time delay on retransfer.
 - e. Close differential voltage sensing of normal source phases (pick-up adjustable from 85% to 100% of nominal and dropout adjustable from 75% to 98% of pick-up), factory set to pick-up at 95% and drop out at 85% of nominal.
 - f. Independent single phase voltage (85% to 100%) and frequency (90% to 100% pick-up) sensing of the emergency source to prevent premature transfer, factory set to pick-up at 90% of nominal voltage and 95% of nominal frequency.
 - g. Test switch, momentary type, to simulate failure to normal source.
 - h. Pilot lights to indicate switch position.
 - i. Auxiliary contacts, 1 closed on normal and 1 closed on emergency, rated 10 A, 480 V.
 - j. Time delay and sensing functions shall be adjustable over the ranges specified herein and shall operate with minimum drift, not to exceed $\pm 1\%$ of set frequency, $\pm 2\%$ of set voltage, and $\pm 10\%$ of set time delay, over the temperature range of -5°F to 160°F . The control panel shall be provided with a protective cover and an isolation plug in the wiring harness to disconnect the control wiring between the control panel and the main transfer panel. The control panel shall not draw more than 15 VA continuously under normal operating conditions.
 - k. Contacts that close when normal source fails for initiating engine starting, rated 10 A, 32 V DC.
 - l. In phase monitor control for motor load transfer, with capability of switching between synchronized utility sources.
 - m. Load shed control circuit shall operate from a normally closed set of remote contacts so that upon opening the remote contacts, the automatic transfer switch load shall remain connected to the normal source or shall be transferred to the normal source regardless of the normal power source condition.

C. Bypass-Isolation Switches:

1. A 2-way bypass-isolation switch shall provide manual bypass of the load to either source and permit isolation of the automatic transfer switch from source and load power conductors. Main contacts shall be manually driven.
2. Bypass to the load-carrying source shall be effected without any interruption of power to the load.
3. The bypass handle shall provide 3 operating modes: bypass-to-normal; automatic; and bypass-to-emergency. The operating speed of the bypass contacts shall be the same as that of the associated automatic transfer switch and shall be independent of the speed at which the manual bypass handle is operated. In the automatic mode, the bypass contacts shall be out of the power circuit.

4. The isolation handle shall provide 3 operating modes: closed, test, and open. The test mode shall permit testing of the entire emergency power system, including the automatic transfer switches. The open mode shall completely isolate the automatic transfer switch from source and load power conductors. When in the open mode, it shall be possible to withdraw the automatic transfer switch for inspection or maintenance without removal of power conductors.
5. When in the test or open modes, the bypass switch shall function as a manual transfer switch allowing transfer and retransfer of the load between the 2 available sources without the feedback of load regenerated voltage to the transfer switch.

D. Closed-Transition Transfer Switches:

1. Closed-transition transfer switches shall transfer without load interruption by momentarily connecting both sources of power when both sources are available and within acceptable parameters. The maximum interconnection time shall be no greater than 100 ms. The closed-transition transfer switch shall operate as a make-before-break switch.
2. Closed-transition transfer switch controllers shall include the following features in addition to those listed for automatic transfer switches:
 - a. Source differential sensing for closed-transition operating mode. The sensor shall enable transfer/retransfer between energized sources in the closed-transition mode only when the two sources have a maximum voltage differential of 5%, frequency differential of 0.2 Hz, and are within 5 electrical degrees of each other.
 - b. Time delay on failure to synchronize normal and emergency sources prior to closed-transition transfer (1 min to 5 min), factory set at 5 min.
 - c. Voltage, frequency, and phase rotation sensing on both the normal and emergency sources.

E. Remote Annunciator:

1. Industrial grade interface providing transfer switch status indication and transfer/retransfer control for up to 8 transfer switches. LED/LCD indication of switch status and positions, push buttons to initiate transfer switch operation and testing.
 - a. Manufacturer: ASCO 5350 Remote Annunciator or equal by Russelectric, or Zenith.

2.6 GENERATOR DOCKING STATION

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. TRYSTAR; ESL Power Systems

B. General Requirements

C. Docking station shall include 16 Series Camlok Panel Mounts for use as connection to Portable Generator.

D. Entire package must be listed to ETL or UL 1008 Standards. UL listing of individual components is not acceptable.

E. Enclosures:

1. NEMA 3R rain-tight, 304 GA aluminum enclosure
2. Pad-lockable front door shall include a hinged access plate at the bottom for entry of cables from portable generator or portable load bank. NEMA 3R integrity shall be maintained with access plate open for cable entry.
3. Front and side through a front access panel shall be accessible for maintenance.
4. Top, side, and bottom through a front access panel shall be accessible for permanent cabling.

F. Finishes:

1. Paint after fabrication. Finish by Architect.

G. Phase, Neutral, and Ground Buses:

1. Material: Silver-plated Copper
2. Equipment Ground Bus: bonded to box.
3. Isolated Ground Bus: insulated from box.
4. Ground Bus: 50% of phase size.
5. Neutral Bus: Neutral bus rated 100 percent of phase bus.
6. Round edges on bus.
7. Temporary generator connectors shall be Camlok style mounted on gland plate.
8. Camlok shall be color coded according to system voltage
9. A phase – Black or Brown
10. B phase – Red or Orange
11. C phase – Blue or Yellow
12. N Neutral – White
13. G Ground – Green
14. Temporary connectors shall include protective flip lids to prevent accidental contact.
15. Permanent connectors shall be broad range set-screw type, located behind an aluminum barrier.
16. Short Circuit & Withstand Rating
17. Shall be minimum 65KAIC unless otherwise indicated on drawings.

H. Voltage & Amperage:

1. 480V, 3 phase. Ampacity as indicated on drawings.

I. Phase Rotation Monitor Device:

1. Phase monitoring relay to be Siemens 3U4512-1AR20 or equal.
2. Integral circuit breaker.
3. Must be UL 489 Listed Breaker
4. Breakers shall be removable for service and maintenance.
5. Circuit breaker manufacturer shall be same as the switchboard manufacturer.
6. Breaker shall be equipped with an electronic trip unit with the following front panel adjustments:
7. Long time pick-up.
8. Long time delay.
9. Short time pick-up.
10. Short time delay.
11. Instantaneous pick-up.
12. Energy reducing maintenance switch if 1,200 A or larger
13. Ground fault alarm.

J. Additional accessories shall be included in submittal drawings as follows:

1. A: Two Wire Auto Start
2. C: Battery Charger Receptacle 20A GFCI 125V
3. D: Block Heater Receptacle 30A L5-30 125V
4. M: Listed Monitoring Device

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's recommendations.

- B. Install 2 remote annunciator and control panels where indicated on the Drawings, including interconnecting wiring and conduit.
- C. Install remote emergency manual stop pushbutton external to the engine-generator set enclosure. Provide a label as specified in Section 260010, 2.10, E on the pushbutton station enclosure, stating "EMERGENCY GENERATOR STOP PUSHBUTTON".
- D. Provide control wiring from transfer switches to engine-generator set controls for automatic start-stop control.
- E. Provide control wiring from transfer switches to each group of the elevator controllers for transfer switch position and load disconnect control. Refer to Division 14, Conveying Equipment for specific elevator requirements.
- F. Provide control wiring from each closed-transition transfer switch to the associated upstream normal and emergency source shunt trip circuit breakers for remote operation by protective relaying.
- G. Fill cooling systems with 50% ethylene glycol solution.

3.2 OIL SAMPLE ANALYSIS

- A. Service facility oil sample analysis laboratory shall be open to inspection during normal working hours. Laboratory shall perform oil sample analysis at no additional cost to the Owner for the kit specified hereinbefore.
- B. Scheduled oil sampling shall be of the atomic absorption spectrophotometry method and shall be accurate to within a fraction of 1 ppm by weight for the following elements: iron, chromium, copper, aluminum, silicon, and lead.
- C. In addition, samples shall be tested for the presence of water, fuel dilution, and antifreeze.
- D. Immediate notification shall be provided to the Owner when analysis shows any critical reading. If readings are normal, a report showing that the equipment is operating within established parameters shall be provided.

END OF SECTION 262000

SECTION 264020 - SERVICE ENTRANCE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other electrical systems are specified in other Sections of Division 26.
- B. This Section covers the installation of the electric service and service entrance equipment.
- C. Switchboards used for service entrance equipment are is specified in Section 264400, Switchboards. Section 264450.
- D. Underground ductsare specified in Section 261150, Underground Ducts, Manholes and Handholes.
- E. Surge protective devices used for service entrance equipment are specified in Section 266710, Surge Protective Devices.
- F. This Section includes responsibilities and obligations in support of the performance verification specified in Section 260090, Electrical Performance Verification.

1.2 DEFINITIONS

- A. The utility referred to herein is Duke Energy Power Company.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 PRIMARY SERVICE

- A. The utility will furnish and install the primary service conductors, and make primary connections.

3.2 SERVICE TRANSFORMERS

- A. The utility will furnish and install the service transformers. Provide labor, materials and services required by the utility in conjunction with the installation of the service transformers.
- B. Make arrangements with the utility for installation of the service transformers and the primary services. Furnish the utility advance notice of the required service date to permit the service installation to be complete and ready when needed.

3.3 SECONDARY SERVICES

- A. Furnish and install the secondary services as indicated on the Drawings. Coordinate the termination of the secondary service conductors within the transformer enclosure with the utility requirements.

3.4 SURGE PROTECTIVE DEVICES

- A. Install immediately downstream of main service device.

END OF SECTION 264020

SECTION 264400 - SWITCHBOARDS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other electrical systems are specified in other Sections of Division 26.
- B. This Section covers switchboards.
- C. Refer to Section 264020, Service Entrance, for utility service metering transformer requirements.
- D. Refer to Section 264750, Overcurrent Protective Devices, for switches, circuit breakers, and fuses.
- E. Refer to Section 266710, Surge Protective Devices.
- F. This Section includes responsibilities and obligations in support of the performance verification specified in Section 260090, Electrical Performance Verification.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. North Carolina State Electrical Code-2018.
 - 2. NECA 400-2007.
- B. Codes, standards and regulations specified herein refer to the edition date. Revisions and addenda to these codes, standards and regulations shall be part of these specifications. Provisions of referenced codes, standards and regulations do not create duty or responsibility by the Architect or the Owner, unless otherwise specified herein.
- C. Codes, standards and regulations referred to are minimum standards. Where the requirements of these specifications or drawings exceed those of the codes, standards and regulations, the drawings or specifications govern.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Switchboards shall be indoor, sectional, totally free-standing, steel-enclosed, dead front low voltage type, constructed and tested in accordance with NEMA PB 2-2011 and UL 891-2019. Where used as service entrance equipment, switchboards shall be rated and labeled for that use.
- B. Switchboards shall be designed for a 3-phase, 4-wire system with voltages indicated on the Drawings.
- C. Switchboards shall be front accessible, with individually mounted main and group mounted feeder devices, and arranged as indicated on the Drawings and as specified herein. Controls and metering devices are indicated on the Drawings or specified herein.
- D. Manufacturer: Eaton Pow-R-Line C, GE, Siemens Sentron, or Square D.

2.2 ENCLOSURES AND BARRIERS

- A. Switchboard sections shall be 90" high, die formed from code gauge steel, furnished with rust-inhibitive primer and baked on enamel light gray color. Exterior structural channel iron sills shall be provided at front and back, making a total height of approximately 91.5".
- B. Barriers: service switchboards shall have code gauge steel, or aluminum, front-to-back and top-to-bottom on each side of main circuit breakers. Where busses pass through barriers, close the openings around the bars with insulating sheet material.
- C. Doors: formed hinged type with knurled thumb screws on front sections, with ventilation grilles. Top and end plates shall be flat and screw removable.
- D. Cable racks: insulated and installed in bus compartment of rear accessible switchboards on each side of each section.

2.3 BUSSING

- A. Silver-plated copper. Bussing shall be braced for symmetrical amperes fault current as indicated on the Drawings.
- B. Main busses shall be the same ampacity as the maximum frame rating of the main breaker shall extend full size the entire length of the switchboard.
- C. The neutral bus shall be full size and run with the phase busses and insulated from the frame.
- D. A 0.25" x 2" copper equipment ground bus shall be run through and bolted or brazed to each section frame. Provide lugs on the ground bus for connection of each main and feeder grounding conductor indicated on the Drawings and specified herein. Provide a removable 0.25" x 2" copper ground link between neutral and ground busses for service switchboards.
- E. Spaces for future circuit breakers are indicated on the Drawings. The spaces shall be bussed completely including connectors, ready to receive breakers without having to install additional bus, parts, or hardware. This provision shall include ground fault relaying, control and interlock wiring, and metering.
- F. Provide lugs as specified in Section 261200, Building Wire and Cable, 600 V, on the load bus of all feeder breakers, spaces, and on neutral and equipment ground busses for feeders and mains. Provide UL listed lugs on the load side of overcurrent devices where bus extensions are not used.
- G. Provide busway connections to switchboard enclosure and bus risers from switchboard devices to the point of entrance to and exit from the switchboard.

2.4 MAINDEVICES

- A. Insulated case circuit breakers: stationary solid state tripping, ground fault relaying type.

2.5 FEEDER DEVICES

- A. Molded case circuit breakers shall be of number, frame size, interrupting capacity, and trip rating as indicated on the Drawings. Where space for a future breaker is indicated on the Drawings, buswork, concealed behind a blank cover, shall be provided.

2.6 GROUND FAULT PROTECTION

- A. Main and feeder devices 1000 A and larger in 480 V systems shall be equipped with a ground fault protection system, including control power source.
- B. Feeder devices shall be equipped with ground fault protection systems coordinated with that of the main device.
- C. Ground fault protection shall be fully selective such that the feeder device and not the service device shall open on ground faults on the load side of the feeder device. A 6 cycle minimum separation between the service and feeder ground fault tripping bands shall be provided; operating time of the disconnecting devices shall be considered in selecting the time spread between these 2 bands to achieve 100% selectivity. Fully selective operation shall be provided by a wired interlocking system between the service and feeder devices.
- D. Ground fault protection system: as specified in Section 264750, Overcurrent Protective Devices.

2.7 ENERGY-REDUCING MAINTENANCE SWITCHING

- A. Circuit breakers rated or adjustable to 1200 A or higher shall be provided with Energy-Reducing Maintenance Switching provisions.
- B. Energy-Reducing Maintenance Switching system: as specified in Section 264750, Overcurrent Protective Devices.

2.8 INSTRUMENTATION

- A. Instruments shall be provided on fronts of switchboards:
 - 1. Electronic power monitors with digital LCD or LED display, minimum 1% accuracy, on the load side of the each main breaker. Monitors shall be microprocessor-based devices with nonvolatile memory, local display of information, and Modbus RTU and TCP/IP capabilities. Metered values (true RMS) shall include multiphase A and volts, watts, VARS, volt-amperes, watt-hours and VAR-hours, amperes and watts demand, frequency, power factor, and harmonic distortion. Modules shall be mounted on a hinged door, and provided with instrument transformers mounted in the switchboard.
 - 2. Front accessible Ethernet ports (RJ-45 connectors) shall be provided for temporary local access. Connectors shall include protective covers tethered to avoid accidental loss or damage. Ports shall be wired to power monitors in such a way that standard "straight-through" Ethernet cables may be used. Special "cross-over" cables shall not be required. Ports shall be provided for local access only and shall be provided in addition to the permanent Ethernet ports inside the equipment.
 - 3. Manufacturer: Eaton IQ 260 series, GE EPM 6000, Siemens PAC4200, or Square D PM820.

2.9 MIMIC BUSSES AND NAMEPLATES

- A. Engraved laminated white core mimic busses 0.5" wide shall be attached to the front of the switchboards, with stainless steel screws, tracing the bussing and switching functions.
- B. Lines for normal service busses and breakers shall be black; lines for emergency service busses and breakers shall be red.
- C. Provide engraved laminated white core nameplates with 0.5" high letters mounted on the front for each device. For devices with integral current limiters, provide a nameplate mounted near each set of limiters

giving complete catalog ordering information. Nameplate backgrounds shall be as specified in Section 260010, Electrical General.

2.10 SURGE PROTECTIVE DEVICES

- A. Provide integral surge protective devices as described in Section 266710, Surge Protective Devices.

PART 3 - EXECUTION

3.1 CABLE RACKING

- A. Cable installed in switchboards shall be neatly placed by feeders with cable ties and supported vertically and horizontally with rigid insulating material. Provide main and load feeder cable lashing from the point where the feeders enter the switchboard to the point where cables lace into terminals, in accordance with the manufacturer's instructions for the short circuit bracing level specified herein. Install manufacturer's lashing instructions in each vertical section.
- B. Vertical cable runs in rear compartments of switchboards shall be made on insulated racks on the sides of the cubicle turning out horizontally on the same level as the loadside studs. Maximum length of unsupported cable shall be 18".
- C. Only those cables intended for termination within a vertical section shall be installed within that section.

3.2 INSTRUMENTATION

- A. Provide conduit and network cables to connect power monitors via Modbus TCP/IP to a data outlet located in the electrical room adjacent to the switchboard as indicated on the Drawings.
- B. Provide conduit and RS-485 cables for external connections between the power monitors and the Modbus RTU serial bus as indicated on the Drawings per the manufacturer's requirements. Connections of devices to the Modbus RTU serial bus internal to the switchboard shall be completed by the switchboard manufacturer.

END OF SECTION 264400

SECTION 264500 - GROUNDING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other electrical systems are specified in other Sections of Division 26.
- B. This Section covers grounding.
- C. This Section includes responsibilities and obligations in support of the performance verification specified in Section 260090, Electrical Performance Verification.

1.2 GROUND RESISTANCE

- A. The resistance of the grounding system to earth shall be a maximum of 5 ohms.

1.3 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. North Carolina State Electrical Code-2018.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Electrical wire and cable shall have lead content less than 300 parts per million.

2.2 GROUND RODS

- A. Copper-clad steel of diameter and length indicated on the Drawings.

2.3 GROUNDING CONDUCTORS

- A. Except as otherwise specified herein or indicated on the Drawings, electrical system and equipment grounding conductors shall be insulated. Insulation shall be rated 600 V. Conductors shall be of same material as feeders and branch circuits.
- B. Conductors installed underground to interconnect ground rods, copper plates, and reinforcing or structural steel and extended to equipment as grounding electrode conductors shall be bare copper and minimum #3/0 AWG.

2.4 CORROSION INHIBITOR

- A. Colloidal copper suspended in a waterproof corrosion and rust inhibitor compound.
- B. Manufacturer: Burndy, or Thomas & Betts.

2.5 GROUND CLAMPS

- A. UL listed.

2.6 GROUND FIELD CONNECTIONS

- A. Compression-type connectors, UL listed for use as grounding and bonding equipment.
 - 1. Manufacturer: Burndy, ILSCO, or Thomas & Betts.
- B. Exothermic process.
 - 1. Manufacturer: Burndy, or Erico.

2.7 LUGS

- A. UL listed for use as grounding and bonding equipment, with 2 bolt hole pads.

PART 3 - EXECUTION

3.1 EQUIPMENT GROUNDS

- A. Equipment, enclosures and raceways shall be grounded.
- B. A green colored or green identified grounding conductor shall be installed in raceways with the phase conductors.
- C. Bond ground conductors together and to enclosures using grounding lugs at origin of circuits, at intermediate pull boxes, individual circuit breakers, disconnect switches, and to panelboards or equipment at terminations.

3.2 SWITCHBOARD AND PANELBOARD GROUNDS

- A. Grounding conductors shall be connected to grounding busses provided in the equipment.

3.3 GROUND FIELD CONNECTIONS

- A. Underground connections between conductors and ground rods, flat plates, structural steel, and reinforcing steel shall be made with the exothermic process. UL listed compression-type connectors with corrosion inhibitor compound shall be used on above grade ground bus connections. UL listed ground clamps shall be used for pipe connections.

3.4 GROUNDING AND BONDING CONNECTOR HARDWARE

- A. Provide bolts, nuts, lock washers, flat washers, and Belleville washers (for dissimilar metals) of silicon bronze or type 316 stainless steel as recommended by the manufacturer. Tighten connections to manufacturer's recommended torque values.

END OF SECTION 264500

SECTION 264510 - LIGHTNING PROTECTION SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other electrical systems are specified in other Sections of Division 26.
- B. This Section covers the lightning protection system.
- C. This Section includes responsibilities and obligations in support of the performance verification specified in Section 260090, Electrical Performance Verification.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. NFPA 780-2020.
 - 2. UL 96A-2016.
- B. The installer shall be UL listed and shall be certified by the Lightning Protection Institute.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Concealed type system, complete with equipment and connections.
- B. Electrical wire and cable shall have lead content less than 300 parts per million.

2.2 FITTINGS

- A. Bolted, pressure type.

2.3 CONDUCTORS AND AIR TERMINALS

- A. Copper conductors. Class I equipment, in accordance with NFPA 780-2020.

2.4 MANUFACTURER

- A. Advanced Lightning Technology, Capital, East Coast, Harger, Independent, National Lightning Protection, Robbins, or Thompson.

PART 3 - EXECUTION

3.1 GENERAL

- A. Provide a lightning protection system, installed in compliance with UL or LPI-IP Lightning Protection Inspection Certificate requirements.

- B. Obtain and submit a UL Master Label or an LPI-IP Master Installation Certificate.

END OF SECTION 264510

SECTION 264600 - DRY-TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other electrical systems are specified in other Sections of Division 26.
- B. This Section covers dry-type transformers.
- C. Vibration isolation and seismic requirements are specified in Section 260010, Electrical General.
- D. Transformers shall meet the requirement of 10 CFR 431-2019-Energy Efficiency Program for Certain Commercial and Industrial Equipment.
- E. Transformer efficiency shall be measured according to 10 CFR 431-2019.
- F. This Section includes responsibilities and obligations in support of the performance verification specified in Section 260090, Electrical Performance Verification.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. NECA 409-2015.
 - 2. North Carolina State Electrical Code-2018.

PART 2 - PRODUCTS

2.1 TRANSFORMERS (600 V NOMINAL OR LESS)

- A. Ventilated, 480 V, 3-phase, delta primary, 208/120 V, 3-phase, 4-wire, wye-connected secondary unless otherwise indicated on the Drawings, with full capacity standard taps in primary winding.
- B. Transformers shall be manufactured and tested in accordance with UL 1561-2011 (R2015).
- C. Windings: copper.
- D. Insulation: 220°C.
- E. Temperature rise: 115 °C.
- F. Coils and core shall be mounted on vibration isolators.
- G. Enclosures shall be UL listed for indoor installation unless indicated otherwise on the Drawings for outdoor installation.
- H. Manufacturer: Acme, Eaton, GE, Powersmiths, Siemens, Square D, or Uptegraff.

PART 3 - EXECUTION

3.1 GENERAL

- A. Ground the secondary neutral.
- B. Install transformers on vibration isolators. See Section 260010, Electrical General for requirements.
- C. Adjust transformer taps for proper system voltage.

END OF SECTION 264600

SECTION 264710 - PANELBOARDS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other electrical systems are specified in other Sections of Division 26.
- B. This Section covers lighting and appliance branch circuit panelboards and distribution panelboards.
- C. Refer to Section 264020, Service Entrance for utility service requirements.
- D. Refer to Section 264750, Overcurrent Protective Devices for circuit breakers.
- E. Refer to Section 266710, Surge Protective Devices for surge protective devices.
- F. This Section includes responsibilities and obligations in support of the performance verification specified in Section 260090, Electrical Performance Verification.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. NECA 407-2015.
 - 2. NEMA PB 1-2011.
 - 3. North Carolina State Electrical Code-2017.
 - 4. UL 50-2015.
 - 5. UL 67-2018.

PART 2 - PRODUCTS

2.1 BUS MATERIAL

- A. Buswork shall be copper.

2.2 CABLE CONNECTIONS

- A. Cable connection lugs shall be UL listed for use with the type of material to which they are connected.

2.3 TYPE MAINS

- A. Main lugs or main breakers shall be provided as indicated on the Drawings.

2.4 GROUND BUS

- A. Provide ground bus bars in cabinets.

2.5 CIRCUIT BREAKERS

- A. Protective devices in panelboards shall be molded case thermal-magnetic, with bolt-on type automatic circuit breakers of frame types, number poles, trip ratings and quantities as indicated on the Drawings and as specified herein.
- B. Main and branch breakers shall be rated for the fault current level indicated on the Drawings, minimum 10000 A RMS symmetrical for 208 V or 120 V AC, and 14000 A RMS symmetrical for 480 V or 277 V AC. Each breaker shall be fully rated for the fault current available at its point of application.
- C. Circuit breakers rated or adjustable to 1200 A or higher shall be provided with Energy-Reducing Maintenance Switching provisions as specified in Section 264750, Overcurrent Protective Devices.
- D. Spaces for future breakers shall be equipped with hardware to accept breakers, and shall be bussed to accept a minimum 60 A breaker without revisions, unless otherwise indicated on the Drawings.
- E. Multipole breakers shall have internal common trip.

2.6 CABINETS

- A. Cabinets shall be galvanized code thickness steel with door and trim finished in gray enamel or lacquer. Mounting shall be flush or surface as indicated on the Drawings. Doors shall have combination latch and cylinder lock and shall be hinged door-in-door type. Locks shall be keyed alike. Gutter space shall be in accordance with UL 67-2018, except that cabinets enclosing a through-feeder shall have an additional 4" width in the gutter on the feeder side.

2.7 SURGE PROTECTIVE DEVICES

- A. Provide surge protective devices in panelboards where indicated on the drawings.

2.8 LABELING

- A. Panelboards shall be UL listed as "Suitable for Use as Service Entrance Equipment" and labeled as such by the manufacturer where so used.

2.9 MANUFACTURER

- A. Panelboards shall be by the same manufacturer as switchboards.

PART 3 - EXECUTION

3.1 ELEVATION

- A. Unless otherwise indicated on the Drawings, install top of panelboard cabinets 78" above the finished floor.

3.2 SUPPORT

- A. Panelboards shall be anchored to the building structure.

3.3 SPARE CONDUITS

- A. From each flush-mounted panelboard, provide four spare 1" empty conduits stubbed up and turned out into the ceiling plenum above. From each flush-mounted panelboard installed on floors above slab on grade, provide two additional spare 1" empty conduits stubbed down through the floor and turned out into the ceiling plenum below. Terminate spare conduits in an accessible location and with capped metal bushings.

3.4 MULTIWIRE BRANCH CIRCUITS

- A. Group conductors within panelboards.
- B. Install handle ties on individual single-pole circuit breakers serving multiwire branch circuits.

END OF SECTION 264710

SECTION 264750 - OVERCURRENT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other electrical systems are specified in other Sections of Division 26.
- B. This Section covers overcurrent protective devices for systems operating at 600 V AC or less in equipment furnished under Division 26.
- C. This Section includes responsibilities and obligations in support of the performance verification specified in Section 260090, Electrical Performance Verification.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. North Carolina State Electrical Code-2018.
 - 2. UL 489-2016.
 - 3. UL 1066-2012 (R2017).

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

- A. Quick-make quick-break fusible type. Fusible switches with frames 30 A through 600 A shall be furnished with fuses and matching fuse clips specified herein.
- B. Switches shall incorporate safety cover interlocks to prevent opening the cover with the switch in the on position or prevent placing the switch in on position with the cover open, and a defeater.
- C. Handles shall have provisions for padlocking and shall clearly indicate the on or off position. Front cover doors shall be capable of being padlocked in the closed position.
- D. Manufacturer: Eaton, GE, Siemens, or Square D.

2.2 MOLDED CASE CIRCUIT BREAKERS

- A. Molded case circuit breakers shall provide complete circuit overcurrent protection by having inverse time and instantaneous tripping characteristics, and where indicated on the Drawings or specified herein shall be current limiting.
- B. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip free. Automatic tripping of the breaker shall be indicated by handle position. Contacts shall be nonwelding silver alloy and arc extinction shall be accomplished by means of arc chutes.
- C. Minimum circuit breaker interrupting capacities shall be as indicated on the Drawings with the minimum rating level as specified herein.

1. Lighting and branch circuit panelboard circuit breakers shall be rated a minimum of 14000 RMS symmetrical AIC for 277 V and 480 V, and 10000 RMS symmetrical AIC for 120 V and 208 V.
 2. Circuit breakers used in combination starters shall have a minimum interrupting capacity equal to or greater than the short circuit capacity shown for the panelboard, switchboard, or switchgear immediately upstream between the device and the source.
 3. Individually mounted circuit breakers shall have a minimum interrupting capacity equal to or greater than the short circuit capacity shown for the panelboard, switchboard immediately upstream between the device and the source.
 4. Protective devices in panelboards shall be fully rated for the fault current available at the point of application. Series rated devices shall not be provided.
- D. Individually mounted circuit breakers shall incorporate hinged covers with external operating handles. Devices shall be removable from the front.
- E. Breakers with frames 600 A and larger shall include solid state trip complete with built-in current transformers, solid state trip unit and shunt trip. Breakers shall have trip ratings as indicated on the Drawings. Trip units shall have adjustable short time setting with a fixed instantaneous override for circuit protection. Main breakers shall be provided with additional short delay trip time adjustment for increased system coordination. Where indicated on the Drawings, or specified herein, breakers shall have built-in ground fault protection with adjustable pick-up rating not exceeding 1200 A. Ground fault time delay shall be adjustable 0.1 s to 0.5 s. Breakers shall have a neutral ground fault current transformer for 4-wire systems.
- F. Insulated Case Circuit Breakers:
1. Breakers shall be UL listed, insulated case type, minimum AIC as indicated on the Drawings. Breakers shall be stationary, 100% equipment rated units, with pad-lock function. Breakers shall be listed for series rating of 150000 RMS symmetrical AIC minimum with Class L fuses applied on the line side.
 2. Breakers shall be equipped with integral solid state programmer with adjustable current, adjustable long-time delay, adjustable short-time delay, adjustable instantaneous pick-up, adjustable ground fault pick-up, adjustable ground fault delay, and overload, short circuit, and ground fault trip indication targets. Ground fault trip range shall be approximately 25% to 100% of nominal breaker rating, up to a maximum of 1200 A.
- G. Manufacturer: Eaton, GE, Siemens, or Square D.

2.3 FUSES

- A. Fuses in devices through 600 A capacity: UL Class RK1 current limiting, dual element, time-delay type with Class R fuse clips for motor branch circuits and transformer feeders, and UL Class J current limiting, quick acting type for other applications.
- B. Fuses shall be voltage rated for the system in which they are installed.
- C. Manufacturer: Bussmann, Edison Fusegear, Ferraz Shawmut, GE, or Littelfuse.

2.4 SPECIAL FUSES

- A. Fuses in control circuits and special applications shall be of type and size for duty for the specific application.

2.5 ENERGY-REDUCING MAINTENANCE SWITCHING

- A. Circuit breakers identified in this Section and other Sections with Energy-Reducing Maintenance Switching shall reduce the instantaneous pickup value to no intentional delay, via circuit breaker trip unit or remote settings via a remote switch.
- B. A local status indicator shall be provided to indicate status.
- C. The Energy-Reducing Maintenance Switching setting shall be activated and deactivated without opening the equipment. When activated, the setting shall not compromise circuit breaker phase protection and when disabled, recalibration of the circuit breaker settings shall not be required.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install overcurrent protective devices as indicated on the Drawings or specified herein, in accordance with manufacturer's written instructions.

3.2 FUSIBLE SWITCHES

- A. Install fuses in fusible switches.
- B. Provide fuses in fusible switches serving packaged air conditioning units, elevators, in accordance with manufacturers' recommendations and nameplate requirements.

3.3 CIRCUIT BREAKERS

- A. Fasten circuit breakers without causing mechanical stresses, twisting or misalignment being exerted by clamps, supports, or cabling.

3.4 SPARE FUSES

- A. Provide 3 spare fuses of each size, UL class, and voltage rating and turn over to the Owner. Obtain a receipt for same.

3.5 FUSE STORAGE

- A. Furnish a galvanized sheet metal cabinet with hinged door and latch in the main electrical service room to contain spare fuses. To the back side of the door attach a type written list of spare fuses itemized to show quantity, amperage, class and catalogue order number.

END OF SECTION 264750

SECTION 264760 - INDIVIDUAL CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other electrical systems are specified in other Sections of Division 26.
- B. This Section covers individual circuit breakers.
- C. This Section includes responsibilities and obligations in support of the performance verification specified in Section 260090, Electrical Performance Verification.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Circuit breakers shall be the molded case frame type, with number of poles and trip rating as indicated on the Drawings. Enclosures shall be NEMA 1 in dry spaces, and NEMA 3R in wet or exposed locations.
- B. Breakers: as specified in Section 264750, Overcurrent Protective Devices.

2.2 MANUFACTURER

- A. Circuit breakers shall be by the same manufacturer as panelboards.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Circuit breakers shall be supported and located in same manner as specified herein for disconnect switches.

END OF SECTION 264760

SECTION 265100 - LUMINAIRES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other electrical systems are specified in other Sections of Division 26.
- B. This Section covers luminaires, both interior and exterior.
- C. Modular flexible wiring systems are specified in Section 261260, Modular Flexible Wiring Systems.
- D. Seismic restraints are specified in Section 260010, Electrical General.
- E. This Section includes responsibilities and obligations in support of the performance verification specified in Section 260090, Electrical Performance Verification.

1.2 SPACE CONDITIONS

- A. Exact locations of luminaires shall be as indicated on the architectural reflected ceiling plans and wall elevations. Where variance exists between the Electrical and Architectural Drawings, the Architectural Drawings shall govern.

1.3 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. North Carolina State Electrical Code-2018.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Luminaires shall be UL listed, and factory wired.
- B. Painted metal components shall be painted after fabrication.

2.2 SUSPENDED LUMINAIRES

- A. Suspended luminaires shall have rigid stem pendants and swivel aligners.
- B. Suspended direct/indirect LED luminaires shall have field adjustable aircraft cable suspension. Luminaires shall be provided with straight coiled power cords. Suspension points shall be symmetrically located from the center of the luminaire. Sloped ceiling adaptors shall be provided where applicable.

2.3 RECESSED LUMINAIRES

- A. Recessed luminaires shall have trim and supports provided by the fixture manufacturer and designed for the type of ceiling in which they will be installed.

- B. Recessed LED luminaires in lay-in ceilings shall be the lay-in type unless indicated otherwise on the Drawings, and shall be designed for the type of ceiling and grid in which they will be installed.

2.4 EXTERIOR LUMINAIRES

- A. Exterior luminaires shall be UL classified for damp or wet locations as applicable, and shall be complete with gaskets, cast aluminum weatherproof outlet boxes, and grounding.

2.5 LED LUMINAIRES

- A. Electrical and photometric testing methodology for LED luminaires shall comply with IES LM-79-2019.
- B. Projected long term lumen maintenance of LED light sources shall be determined in accordance with IES TM-21-2011 (Addendum B). Lumen maintenance for LED luminaires shall meet or exceed L70 at 50,000 hours of operation. Lumen maintenance testing shall comply with IES LM-80-2015 Errata 1.
- C. LED drivers shall operate from an input source of 47 Hz to 63 Hz and 90 V to 305 V.
- D. LED modules and drivers shall be field replaceable.
- E. LED luminaires shall have a 5 year written warranty from date of shipment to the site against mechanical or electrical defects under normal conditions of use, including a replacement labor allowance.

PART 3 - EXECUTION

3.1 LUMINAIRES

- A. Install quick-connect type connectors provided by modular flexible wiring system manufacturer.

3.2 INSTALLATION

- A. Installation shall comply with ASTM E580/E580M-2017.
- B. Exterior luminaires shall not be installed until after the building exterior has been rinsed of any corrosive cleaning materials.
- C. Install pendant luminaires so that the luminaire housing does not rotate.
- D. Aircraft cable for suspended direct/indirect LED luminaires shall be attached to the structure above the ceiling.
- E. Luminaires shall be adjusted and installed to provide the lighting pattern for which the fixture is designed.

3.3 SUPPORT

- A. Where a recessed LED or downlight luminaire replaces a section or part of a ceiling tile, the luminaire shall be supported from building structure at two opposite ends. Supports shall be provided with the same type of wire used to support the lay-in ceiling track. In addition to wire supports, lay-in luminaires shall be screwed to the main runners of the lay-in ceiling track at four corners using sheet metal screws. For fire rated suspended ceilings, luminaires shall be screwed to the main runners of the suspended ceiling track at four corners using sheet metal screws.

- B. Surface and pendant mounted and chain hung luminaires shall be supported from the structure above.

3.4 ALIGNMENT

- A. Stem connections to outlet boxes shall be made with swivel aligner box covers. Stems and rods not connected into a raceway system shall be supported with nonrigid connection points to allow the stem or rod to hang vertically.

3.5 LUMINAIRE ADJUSTMENTS

- A. Provide final luminaire adjustments of adjustable luminaires under supervision of the Architect. Adjustments shall be carried out before the final site visit, unless indicated by the Architect. Provide personnel and equipment for this task. Adjustments shall be as directed by the Architect. When aiming and adjusting is completed, locking set screws and nuts and bolts shall be tightened securely.
- B. Luminaires shall be focused during the normal working day; however, where daylight interferes with illumination levels, aiming shall be accomplished at night, at no additional cost to the Owner.
- C. Luminaire adjustments shall be reviewed and approved by the Architect prior to occupancy by the Owner.

END OF SECTION 265100

SECTION 265910 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other electrical systems are specified in other Sections of Division 26.
- B. This Section covers wall switch digital timers, wall box dimmers, occupancy sensors, time switches, photocells, and lighting contactors.
- C. This Section includes responsibilities and obligations in support of the performance verification specified in Section 260090, Electrical Performance Verification.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. North Carolina State Electrical Code-2018.
- B. Codes, standards and regulations specified herein refer to the edition date. Revisions and addenda to these codes, standards and regulations shall be part of these specifications. Provisions of referenced codes, standards and regulations do not create duty or responsibility by the Architect or the Owner, unless otherwise specified herein.
- C. Codes, standards and regulations referred to are minimum standards. Where the requirements of these specifications or drawings exceed those of the codes, standards and regulations, the drawings or specifications govern.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Like products shall be by the same manufacturer.

2.2 WALL SWITCH DIGITAL TIMERS

- A. Wall-mounted digital timer switches shall be programmable to shut off lighting automatically after a preset time. Timer switches shall be single-pole, single-throw, rated 800 W at 120 V, 1200 W at 277 V, and 1/6 hp at 120 V. Switches shall have an adjustable time out setting of 5 minutes to 12 hours. Switches shall be capable of providing audible or visual alerts before lighting shut off. Switches shall have on/off lighting control override pushbutton switch. Switches shall be compatible with electronic ballasts, incandescent lighting, or motor loads. Finish shall be per Architect.
 - 1. Manufacturer: Sensor Switch TS2, or WattStopper TS-400.

2.3 WALL BOX DIMMERS

- A. Solid state, combination dimmer/switch type, designed for flush wall mounting. Dimmers shall be LED or 3-way type as indicated on the Drawings.

- B. Wattage ratings indicated on the Drawings are for individual mounting. Wattage shall be derated in accordance with the manufacturer's recommendations when dimmers are ganged together.
- C. Dimmers shall have positive air gap on-off position, and shall have slide type operation.
- D. Dimmers and faceplates shall be white color; where mounted on natural stained wood surfaces, the color shall be dark brown.
- E. Manufacturer: Sensorswitch sPODMRA, Leviton Monet, Lightolier Vega, or Lutron Nova T★.

2.4 OCCUPANCY SENSORS

- A. General:
 - 1. Occupancy sensors shall not emit audible noise or signals that interfere with electronic devices.
 - 2. Occupancy sensors shall be designed to be compatible with LED drivers.
 - 3. Occupancy sensors shall have field selectable automatic or manual on operation modes.
 - 4. Occupancy sensors shall be designed to have RFI and EMF immunity, zero crossing relay control, and voltage drop protection.
- B. Wall Switch Occupancy Sensors:
 - 1. Sensors shall be low voltage ,60 Hz, with adjustable ambient light levels, adjustable sensitivity and time delay, and manual push button on/off control with LED indicator light. Sensitivity and time delay settings shall have field selectable self-adjusting and manual modes.
 - 2. Occupancy sensors shall have 180° coverage capability.
 - 3. Sensors shall be provided with a manual override feature to bypass the occupancy sensor function and override lights to on when a sensor is malfunctioning. The pushbutton on/off control shall manually turn lights on and off when the sensor is in bypass mode.
 - 4. Dual relay occupancy sensors shall be provided with two fully rated relays for controlling two independent lighting loads or circuits.
 - 5. Dual technology sensors shall be factory preset to require sensing of both technologies to initially trigger the device. Once the device has been triggered, the detection of either technology shall maintain the triggered state. This operating logic shall be field selectable.
 - 6. Sensors finish shall be per Architect.
 - 7. Occupancy sensors shall have a 5 year written warranty. The warranty period shall begin at date of substantial completion. Dual Technology, Passive Infrared and Ultrasonic:
 - a. Manufacturer: Greengate ONW-DT-MV, Hubbell LHMTS1, Leviton ODSMT-MD, or WattStopper DW-100.
 - 8. Dual Technology, Passive Infrared and Ultrasonic, Dual Relay:
 - a. Manufacturer: Greengate, Hubbell, Leviton, or WattStopper.
- C. Ceiling-, Wall-, and Corner-Mounted Occupancy Sensors:
 - 1. Ceiling-Mounted Occupancy Sensors Ultrasonic and Passive Infrared:
 - a. Low voltage, dual technology type, with passive infrared and ultrasonic technologies, with 360° field of view with 2000 ft² coverage area, adjustable ambient light levels, adjustable time delay, isolated relay, and LED indicator light. Sensitivity and time delay settings shall have field selectable self-adjusting and manual modes.
 - 2. Ceiling/Wall/Corner-Mounted Occupancy Sensors, Ultrasonic and Passive Infrared:
 - a. Low voltage, dual technology type, with passive infrared and ultrasonic technologies, with 115° to 180° field of view with 1000 ft² to 2000 ft² coverage area, adjustable ambient light

levels, adjustable time delay, isolated relay, and LED indicator light. Sensitivity and time delay settings shall have field selectable self-adjusting and manual modes.

3. Manufacturer: Greengate, Hubbell, Leviton, or WattStopper.

2.5 PHOTOCELLS

- A. Heavy duty die cast enclosure, weatherproof, gasketed, containing cadmium sulphide hermetically sealed cell. Contacts shall be single-pole, single-throw normally closed. On-off adjustment shall be by movable light level selector. Units shall be designed for mounting on threaded conduit nipple.
- B. Manufacturer: Intermatic K4100 series, or Tork 2100 series.

2.6 EMERGENCY LIGHTING CONTROL RELAY DEVICES

- A. Emergency lighting control relay devices shall consist of relay switching circuitry contained in a NEMA Type 1 wall mountable enclosure to control any type of lighting and to bypass any lighting control device during a normal power failure and transfer to the alternate power source regardless of the control device state. Device features shall include:
 1. UL 924-2016 (R2018) and UL 1008-2014 listed for field installation and suitable for use in indoor and damp locations.
 2. Test switch to test unit under load conditions.
 3. LED indicator lights for normal and emergency power sources.
 4. Operate at 120 or 277 V AC, 60 Hz, and a temperature between -4°F to 131°F.
 5. Lighting load rating of 20 A maximum.
 6. Five-year full warranty from date of installation.
- B. Manufacturer: Bodine GTD20A, Chloride MTD20D, or Dual-Lite ATSD20

2.7 LIGHTING CONTACTORS

- A. Mechanically held type, 20 A, 277 V, 60 Hz maximum rating, number of poles indicated on the Drawings, normally open, NEMA 1 enclosure with hand-off-automatic switch mounted on enclosure. Mechanically held contactors shall have solid state control modules for 2-wire operation.
- B. Manufacturer: Asco, GE, Siemens, or Square D.

2.8 TIME SWITCHES

- A. Microprocessor-based, solid state, single channel time control with 7 day programming capability, 24 hour clock format, LCD display of time-of-day, day-of-week and output status keyboard override. The output shall be a single-pole, double-throw relay with contacts rated at 15 A, resistive and inductive at 120 V. Input shall be 120 V. A minimum of 100 hours of carryover shall be provided with a 9 V alkaline battery. Enclosure shall be NEMA 1 surface-mounted.
 1. Manufacturer: Intermatic, or Tork.

PART 3 - EXECUTION

3.1 GENERAL

- A. Wall-mounted devices shall be installed flush in the wall on which they are located when served by concealed conduit. Where necessary to conceal the conduit or flush mount the device box, masonry or plaster shall be channeled and patched.
- B. Wall-mounted devices shall be surface mounted where their connecting raceways are indicated on the Drawings exposed.
- C. Where 2 or more wall box type lighting control devices are indicated on the Drawings at the same location, they shall be ganged and covered with 1 faceplate.
- D. Install device faceplates and adjust devices to achieve a flush fit with no gaps.
- E. For occupancy sensors, photosensors, and time switches, the manufacturer shall provide factory start-up and training of the installation. Every device in the system shall be tested and adjusted as needed to provide optimum performance of the system. The factory-trained representative shall provide a minimum of 4 hours of training to the Owner's operating personnel. Provide the Owner with certificates of system start-up, and instruction of operating personnel.

3.2 WALL SWITCH DIGITAL TIMERS

- A. Install per manufacturer's installation instructions. Time out adjustment shall be set as directed by the Owner.

3.3 PHOTOCELLS

- A. Mount photocells on threaded conduit nipples, north facing, on roof at locations coordinated with the Architect.

3.4 OCCUPANCY SENSORS

- A. Install per manufacturer's installation instructions. Ambient light level setting shall be adjusted as directed by the Owner.
- B. For sensors set to a manual mode, set the time delay as directed by the Owner.
- C. Sensors in corridors, toilets, open office areas, mail rooms, storage rooms shall be set to self-adjusting mode. Other sensors shall be set to manual mode.
- D. Sensors in private offices, break rooms, conference rooms, shall be set to "manual on" mode. Other sensors shall be set to automatic on mode.
- E. Install dual technology type occupancy sensors per manufacturer's recommendations based on the room type, height, usage, partitions, and other factors that directly affect the sensors' operation.
- F. The locations and quantities of occupancy sensors indicated on the Drawings are diagrammatic and indicate only that the rooms are to be provided with occupancy sensors. The exact locations and quantities shall be determined at the building; refer to manufacturer's installation instructions prior to installation for manufacturer's recommended placement. Locate and aim occupancy sensors in the correct location required for the complete and proper volumetric coverage within the range of coverages of controlled areas

per the manufacturer's recommendations. Rooms shall have 90% to 100% coverage of the controlled area to accommodate occupancy habits of single or multiple occupants at any location within the rooms. Provide additional occupancy sensors if required to properly and completely cover the respective room at no additional cost to the Owner.

- G. The right is reserved to change the location of any sensor in any room before it is permanently installed, without additional cost to the Owner.
- H. Provide control wiring between occupancy sensors, low voltage power supplies, and relays per manufacturer's requirements. Provide additional low voltage power supplies and relays as required at no additional cost to the Owner.
- I. Control wiring shall be installed in raceways in spaces where ceilings are exposed to structure.
- J. Verify adjustment and occupancy sensor placement to ensure a trouble-free occupancy-based lighting control system.

3.5 EMERGENCY LIGHTING CONTROL RELAY DEVICES

- A. Locate emergency lighting control relay devices above finished ceilings in accessible locations above door entrances facing into the zones controlled.
- B. Permanently identify the box or enclosure as a component of the emergency system. Include the normal and emergency circuit numbers.
- C. Mark each designated standby luminaire with red dot labels.

3.6 TIME SWITCHES

- A. Install per manufacturer's installation instructions. Set time switches as directed by the Owner.

END OF SECTION 265910

SECTION 266140 - UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other electrical systems are specified in other Sections of Division 26.
- B. This Section covers continuous duty, on-line, solid state uninterruptible power supply (UPS) systems.
- C. This Section includes responsibilities and obligations in support of the performance verification specified in Section 260090, Electrical Performance Verification.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. UL 1778-2014(R2017).

PART 2 - PRODUCTS

2.1 GENERAL

- A. The UPS shall consist of a solid state inverter, rectifier/battery charger, static bypass transfer switch, integral maintenance bypass switch, synchronizing circuitry, external battery, protective devices and accessories. The UPS shall automatically maintain AC power within the specified tolerances to the critical load, without interruption, during failure or deterioration of the normal power source.
 - 1. The manufacturer shall design and furnish materials and equipment to be fully compatible with electrical, environmental, and space conditions at the site. The manufacturer shall include equipment to properly interface the AC power source to the intended load and the system shall be designed for unattended operation.
- B. Environmental Conditions:
 - 1. The UPS shall be designed to withstand any combination of the following environmental conditions without mechanical or electrical damage or degradation of operating characteristics:
 - a. Operating Ambient Temperature:
 - 1) UPS: 0°C to 40°C without derating.
 - 2) Battery: 25°C ±3°C.
 - b. Storage/Transport Ambient Temperature:
 - 1) -20°C to 70°C.
 - c. Relative Humidity:
 - 1) 0% to 95% noncondensing.
 - d. Altitude:
 - 1) Operating: to 4000' above sea level without derating.
 - 2) Storage/transport: to 50,000' above sea level.
 - 2. Audible noise: maximum 72 dBA measured 5' from the unit.

- C. Manufacturer: APC Galaxy VM.

2.2 INPUT ELECTRICAL CHARACTERISTICS

- A. Voltage range: +10%, -15% of nominal.
- B. Frequency range: $\pm 5\%$.
- C. Rectifier walk-in/inrush current limiting: 20% to 100% of full rated load over 15 seconds (adjustable).
- D. Sub-cycle magnetizing inrush: not to exceed 2-3 times normal full load input current.
- E. Power factor: minimum 0.85 lagging at full load with nominal input voltage.
- F. 2-Step Rectifier Input Current Limit:
 - 1. Step 1: factory set at 115% (adjustable 100% to 125%) full load input current.
 - 2. Step 2: factory set at 100% (adjustable 85% to 125%) for on-generator operation.
- G. 2-Step Battery Charge Current Limit:
 - 1. Step 1: factory set at 10% (adjustable 1% to 25%) maximum battery charging current.
 - 2. Step 2: factory set at 1% (adjustable 1% to 25%) maximum battery charging current.
- H. Maximum input harmonic distortion shall be below 3% at full load and nominal input voltage.

2.3 OUTPUT ELECTRICAL CHARACTERISTICS

- A. Load rating: 104% continuous load rating at 104°F for any combination of linear and nonlinear loads at the capacity of the connected modules.
- B. Voltage regulation: $\pm 0.5\%$ for balanced loads, $\pm 2\%$ for 50% unbalanced loads.
- C. Voltage adjustment range: $\pm 5\%$ manually.
- D. Automatic line drop compensation: adjustable 0% to +5% of nominal voltage.
- E. Frequency regulation: 0.1%.
- F. Voltage Transients:
 - 1. 20% load step: $\pm 4\%$.
 - 2. 50% load step: $\pm 4\%$.
 - 3. 100% load step: $\pm 5\%$.
 - 4. Loss of/return to AC input power: $\pm 1\%$.
 - 5. Transfer to/from bypass: $\pm 4\%$.
- G. Output voltage transients: voltage transients shall be limited to a maximum deviation from nominal system output volts of plus or minus 5% with recovery to within 1% of the nominal output voltage within one electrical cycle (16 ms) for each of the following conditions. Limits shall apply to any UPS load within the UPS rating and frequency shall be maintained at 60 Hz ± 0.1 Hz. The system shall not transfer to bypass under these conditions (except item 3).
 - 1. 100% load step.

2. Loss or return of AC input power, momentary sags, surges or spikes on the input to the UPS (all three phases or single phase).
3. Uninterrupted transfer of the critical load to and from the UPS output and bypass power line (manually initiated or automatic).

H. Voltage Harmonic Distortion:

1. Maximum 4% RMS total, maximum 2% any single harmonic.
2. Maximum 5% RMS total for up to 100% nonlinear load.

I. Overload at Full Output Voltage with $\pm 2\%$ Voltage Regulation:

1. 104% continuously.
2. 125% of full load for 10 minutes.
3. 150% of full load for a minimum of 30 seconds.
4. Overloads in excess of the UPS rating on an instantaneous basis or the overload time periods listed above shall cause the static bypass transfer switch to reverse transfer and allow the bypass AC input source to supply the necessary load fault clearing current required.

J. Current limit: 155% full load current.

K. Fault clearing: sub-cycle current of at least 300% but not more than 500% of normal full load current (when bypass is not available).

2.4 SYSTEM COMPONENTS

A. Rectifier/Battery Chargers:

1. Input current reflected harmonic distortion: input current THD shall be less than 10% THD at full load.
2. AC input current limiting: rectifier/chargers shall include a circuit to limit AC input current to an adjustable level of 100% to 125% of the full input current rating. A second circuit shall provide greater limiting, 85% to 125%, when signaled by an external contact (i.e., operation of an engine-generator set).
3. Battery charge current limit: rectifier/chargers shall include a circuit to limit battery charging current to an adjustable level of 1% to 25% of maximum battery discharge current. A second circuit shall provide greater limiting when signaled by an external contact (i.e., operation of an engine-generator set).
4. Input current walk-in: rectifier/chargers shall provide a feature that limits the total initial power requirement at the input terminals to 20% of rated load and gradually increases power to 100% of full rating over a 15-second time interval.
5. Input circuit breakers: rectifier/chargers shall have an input circuit breaker. The circuit breaker shall be of the same frame size and trip rating to supply full rated load and recharge the battery at the same time. The circuit breaker shall have an undervoltage release to open automatically when control voltage is lost.
6. Fuse protection: each AC phase shall be individually fused with fast-acting fuses so that loss of any semiconductor shall not cause cascading failures. Fuses shall be bolted to bus bars at both ends to ensure mechanical and electrical integrity.
7. DC filters: rectifier/chargers shall have an output filter to minimize ripple current into the battery. The AC ripple voltage of the rectifier DC output shall not exceed 0.5% RMS of the float voltage. The AC ripple current in the battery during float operation shall not exceed 2% RMS of the inverter full load DC current. The filter shall be adequate to ensure that the DC output of the rectifier/charger will meet the requirements of the inverter without the battery connected.
8. Battery recharge: in addition to supplying power for the load, the rectifier/charger shall be capable of producing battery charging current sufficient to replace 95% of the battery discharge power

within 10 times the discharge time. After the battery is recharged, the rectifier/charger shall maintain the battery at full charge until the next emergency operation.

9. Battery equalize charge: an automatic equalize charge timer feature shall be provided to automatically apply an equalize voltage to the battery after a 30 second or longer utility outage that generates a Battery Discharging Alarm. The duration of the equalize charge time shall be adjustable from 0 h to 72 h. Manual override shall be provided for the automatic equalize circuit.
10. Overvoltage protection: there shall be DC overvoltage protection so if the DC voltage rises to the preset limit, the UPS shall shut down automatically and initiate an uninterrupted load transfer to bypass.
11. Battery load testing: the UPS shall be capable of performing battery load testing under operator supervision. To accomplish this, the rectifier/charger will reduce charging voltage to 1.9 V per cell, to force the batteries to carry the load for a short period of time. If the curve of the battery voltage drop indicates diminished battery capacity, the UPS shall display an alarm message on the LCD. If the voltage drop indicates battery failure, the UPS shall terminate the test immediately and annunciate the appropriate alarms.
12. Runtime calibration: UPS shall be provided with this feature for re-calibration of the estimated remaining runtime

B. Inverters:

1. Inverters shall be solid-state, capable of providing rated output power and shall be a pulse width modulated 6-step design and utilize insulated gate bipolar transistors (IGBTs). The IGBTs shall not be paralleled within an inverter assembly, nor will inverter modules be paralleled within a single UPS module. The inverter shall not require an inverter output series static switch/isolator for the purposes of fault isolation or transfers to bypass.
2. Overload capability: inverters shall be able to sustain an overload across its output terminals up to 150% with $\pm 2\%$ output voltage regulation. The inverter shall be capable of at least 300% current for short circuit conditions. If the short circuit is sustained, the load shall be transferred to the bypass source and the inverter shall disconnect automatically from the critical load bus.
3. Output frequency: inverters shall track the bypass continuously providing the bypass source maintains a frequency of 60 Hz ± 0.5 Hz. Inverters shall change the frequency (slew rate) at 0.1 Hz per second (adjustable 0.01 Hz per second to 1.0 Hz per second) to maintain synchronous operation with the bypass. This shall allow make-before-break manual or automatic transfers. If the bypass fails to maintain proper frequency, inverters shall revert to an internal oscillator which shall be temperature compensated and hold the inverter output frequency to 0.1% from the rated frequency for steady-state and transient conditions. Drift shall not exceed 0.1% during any 24-hour period. Total frequency deviation, including short time fluctuations and drift, shall not exceed 0.1% from the rated frequency.
4. Phase-to-phase balance: system logic shall provide individual phase voltage compensation to obtain phase balance of no less than $\pm 2\%$ under all conditions including up to 50% load unbalance, measuring against the three-phase average.
5. Fault sensing and isolation: fault sensing shall be provided to isolate a malfunctioning inverter from the critical load bus to prevent disturbance of the critical load voltage beyond the specified limits. An automatic circuit breaker shall be provided to isolate a malfunctioning inverter from the critical load.
6. Output circuit breakers: inverters shall be provided with a motor-operated circuit breaker to isolate the inverter from the critical load bus. This circuit breaker shall be of the correct frame size and trip rating to supply full load and overload current as specified herein. The circuit breaker shall work in conjunction with the bypass circuit breaker specified herein for both automatic and manual load transfers to and from bypass power.
7. Battery protection: inverters shall be provided with monitoring and control circuits to protect the battery system from damage due to excessive discharge. Inverter shutdown shall be initiated when the battery voltage has reached the end of discharge voltage. The battery end of discharge voltage shall be calculated and automatically adjusted for partial load conditions to allow extended operation without damaging the battery. Automatic shutdown based on nominal discharge time shall not be allowed.

C. Inverter Bypass Operation:

1. For times when maintenance is required or the inverter cannot maintain voltage to the load due to sustained overload or malfunction, a bypass circuit shall be provided to isolate the inverter output from the load and provide a path for power directly from an alternate AC source. The UPS control system shall constantly monitor the availability of the inverter bypass circuit to perform the transfer. The inverter bypass circuit shall consist of a static transfer switch, a circuit breaker to isolate the inverter, and a bypass circuit breaker in parallel with the static transfer switch. The static transfer switch shall consist of two reverse-paralleled silicon controlled rectifiers (SCRs) per phase conductor that can automatically and instantaneously connect the alternate AC source to the load. The inverter isolation breaker and system bypass breaker shall be motor operated circuit breakers, self-protecting in case of a fault in the distribution system. Series rated devices shall not be used for this purpose.
2. Manual load transfers: manual load transfers between the inverter output and the alternate AC source shall be initiated from the control panel. Manually initiated transfers shall be make-before-break utilizing the inverter isolation and bypass circuit breakers. The static switch shall not be required for manual transfers.
3. Automatic load transfers: automatic load transfers between the inverter output and the alternate AC source shall be initiated if an overload condition is sustained for a time period in excess of the inverter output capability or due to a malfunction that would affect output voltage. Transfers caused by overloads only shall initiate an automatic retransfer of the load back to the inverter only after the load has returned to a level within the rating of the inverter source. The UPS system logic shall allow 0 to 5 retransfers (adjustable) within any 1 h period to prevent cyclical transfers caused by overloads.
4. Momentary overloads: in the event of a load current inrush or branch load circuit fault in excess of the inverter rating the static transfer switch shall connect the alternate AC source to the load for up to 40 ms allowing up to 1000% of the nominal rated output current to flow. Output voltage shall be sustained to the extent the alternate AC source capacity permits. If the overload condition is removed prior to the end of the 40 ms time period, the static transfer switch shall turn off and the load shall remain on inverter power. If the overload remains, then a transfer to the alternate AC source shall be completed by closing the bypass circuit breaker.
5. Protection and backfeed prevention: the critical output bus shall be protected from the flow of excess current through the static transfer switch path that may be caused by a low-impedance fault at the output of the UPS system. Each phase of the bypass circuit shall be protected by individual fuses and circuit breakers. Blown fuse monitors shall indicate when a blown fuse will prevent the static transfer switch path from being available for automatic transfers.
6. The static transfer switch shall not backfeed the UPS power to the bypass distribution system while the UPS is operating on battery during a bypass power outage. The static transfer switch shall be provided with redundant bypass power outage sensing circuits. The backfeed prevention system shall operate even if two component failures exist simultaneously. If a shorted SCR is detected, the static transfer switch shall be isolated and an alarm message shall be annunciated. The load shall remain on conditioned and protected power after detection of a shorted SCR and isolation of the static transfer switch.

D. Matching Maintenance Bypass Cabinet:

1. A make-before-break maintenance bypass shall be provided in a cabinet that matches and bolts to the UPS. Thermal-magnetic breakers shall be provided for maintenance bypass (MBB) and for maintenance isolation (MIB). The maintenance bypass shall provide the capability of transferring the critical load from the UPS inverter to the maintenance bypass and back to the UPS inverter with no interruption to the critical load.

E. Display and Controls:

1. UPS control panel: Shall be a backlit, color graphic display with choice of 18 operating languages for indication of UPS status, metering, battery status, alarm/event log and advanced operational features. The display and control panel shall be mounted on the control section door. Display panel shall be 7" color graphical type.
2. Logic: UPS system logic and control programming shall be resident in application specific integrated circuits. Rectifier, inverter and system control logic shall be solid state. Switches, contacts and relays shall only be used to signal the logic system as to the status of mechanical devices or to signal user control inputs. Relays shall be used to isolate the logic for customer external status and alarm signaling.
3. Metered values: microprocessors shall control the display and memory functions of the monitoring system. All three phases of the three-phase parameters shall be displayed simultaneously. Voltage and current parameters shall be monitored using true RMS measurements for accurate ($\pm 1\%$) representation of nonsinusoidal waveforms. The following parameters shall be displayed:
 - a. Input voltage, line-to-line.
 - b. Input current.
 - c. Battery voltage.
 - d. Battery charging/discharging current.
 - e. Inverter voltage, line-to-line.
 - f. Inverter frequency.
 - g. Bypass input voltage, line-to-line.
 - h. Bypass input frequency.
 - i. Load current.
 - j. Load kVA.
 - k. Load kW.
 - l. Total operating hours shall be available on a separate display screen.
4. Power flow indications: a power flow diagram shall graphically depict whether the load is being supplied from the inverter, bypass or battery and provide, on the same screen, the status of the following components:
 - a. AC input circuit breaker.
 - b. Battery circuit breaker.
 - c. Inverter output circuit breaker.
 - d. Bypass circuit breaker.
 - e. Static transfer switch (connected/disconnected).
 - f. Time to overload transfer.
5. Battery status indicator: a battery status indicator shall display DC alarm conditions, shutdown voltages, the present battery voltage, and battery time remaining during discharge. A graphical representation of the battery voltage during the discharge shall be displayed. The graphical representation shall remain in the monitoring system memory until the next discharge occurs and shall be available for review of battery performance, battery charge percentage, battery time remaining and estimated time remaining.
6. Battery cycle monitor: each UPS shall have a battery cycle monitor (BCM) built into the system firmware to document the cycle service of the battery. It shall collect and retain information on the last 132 events that involved discharging the UPS battery.
7. Alarms: control panels shall report the system-level alarms listed below. An audible alarm shall be activated when any of the alarms below occur. Alarms shall be displayed in text form.
 - a. Input failure.
 - b. Control power failure.
 - c. DC ground fault.
 - d. DC capacitor blown fuse.
 - e. Battery circuit breaker open.
 - f. Battery discharging.

- g. Low battery warning.
 - h. Low battery shutdown.
 - i. DC overvoltage shutdown.
 - j. Load on bypass.
 - k. Automatic retransfer primed.
 - l. Manual reset/retransfer.
 - m. Static switch unavailable.
 - n. Bypass not available.
 - o. Bypass phase sequence wrong.
 - p. Output over/under frequency.
 - q. Output undervoltage.
 - r. Output overvoltage.
 - s. Overload.
 - t. Overload transfer.
 - u. Overload shutdown.
 - v. Reverse power.
 - w. Rectifier fuse blown.
 - x. Inverter fault.
 - y. Hardware shutdown.
 - z. Emergency off.
 - aa. Ambient over-temperature.
 - bb. Blower failure.
 - cc. Equipment over-temperature.
 - dd. Over-temperature timeout.
8. Controls: system level control functions shall be:
- a. UPS/bypass transfer pushbuttons.
 - b. AC output voltage adjust $\pm 5\%$.
 - c. Battery circuit breaker trip pushbutton.
 - d. Emergency module off pushbutton with protective cover.
 - e. Alarm silence.
 - f. Control enable pushbutton.
 - g. Display control pushbuttons.
 - h. Alarm reset pushbutton.
9. Visual displays shall provide necessary operator instructions for bringing the UPS on-line and for shutting down the equipment under normal or emergency conditions. A step-by-step procedure shall be provided for each sequence of operation.
10. Emergency power off: UPS control panels shall have a local emergency power off pushbutton with protective cover. Additionally, UPS shall be equipped with provisions for remote emergency power shut-off and dry contact input shall be used for this remote feature. Operation of the emergency power off shall cause:
- a. Uninterrupted transfer of the load to bypass.
 - b. The input, output and battery breakers to open, completely isolating the UPS (except bypass) from power. The UPS shall include provisions for a remote emergency power off function, which either transfers the load to bypass or completely removes power from the critical bus (operator selectable) when activated.
11. Self-Diagnostics:
- a. Present status screen: the control system shall monitor and display the following parameters in a present status screen:
 - 1) Input voltage, line-to-line for all three phases.
 - 2) Input current for all three phases.
 - 3) Inverter voltage, line-to-line for all three phases.
 - 4) Output current for all three phases.

- 5) Inverter frequency.
 - 6) Battery voltage.
 - 7) Battery amperes.
 - 8) Load kVA.
 - b. History status file: a history status file shall contain all of the information in the present status screens except load kVA. The control system shall maintain this information in discreet 4 ms frames, updating memory on a first-in-first-out basis. This shall provide a status recall of a period of at least 256 ms: 160 ms before the malfunction fault; the fault frame; and 92 ms after the malfunction.
 - c. Event history file: the control system shall maintain an event history of the alarm conditions that have occurred during system operation. System memory shall be capable of storing at least 128 events for recall.
 - d. System status file: the control system shall monitor and display the total operating hours for the UPS system.
 - e. Diagnostic aids: the UPS shall be provided with the following built-in diagnostics for troubleshooting and circuit alignment aids:
 - 1) Rectifier in control mode.
 - 2) UPS synchronizing with critical bus load.
 - 3) Positive DC bus ground fault.
 - 4) Negative DC bus ground fault.
 - 5) Bypass frequency higher than system output frequency.
 - 6) Bypass frequency lower than system output frequency.
 - 7) Automatic static transfer switch lockout.
 - 8) Command given to close inverter output circuit breaker.
 - 9) Command given to close bypass circuit breaker.
 - 10) Command give to open inverter output circuit breaker/bypass circuit breaker.
 - 11) Degree of overload.
 - 12) Undervoltage release for battery disconnect switch.
 - 13) Undervoltage release for input circuit breaker.
 12. Remote alarm panel: the remote alarm panel shall have LED alarm lights. An audible alarm shall sound upon any alarm condition. The panel shall be surface mounted in a NEMA 1 enclosure. The remote alarm panel shall annunciate the following conditions:
 - a. Load on UPS.
 - b. Load on bypass.
 - c. Battery discharging.
 - d. Low battery warning.
 - e. Overload.
 - f. Ambient overtemperature.
 - g. System summary alarm.
 - h. New alarm condition.
- F. Enclosures:
1. Designed to resemble a computer or computer peripheral equipment. Front access only shall be required for maintenance of the equipment.
 2. Forced-air cooling, with air filters, shall be provided. Power plug-in modules shall be cooled by redundant blower motor assemblies located directly under critical components. Internal air baffles shall carry heated air from large magnetic components. Blower motors shall have sealed bearings.
- G. Battery disconnect breakers: each UPS shall have a properly rated circuit breaker (500 V DC) to isolate it from the battery. This breaker shall be in a matching battery cabinet. When open, there shall be no battery voltage in the UPS enclosure. The UPS shall automatically be disconnected from the battery by opening the breaker when the battery reaches the minimum discharge voltage level or when signaled from other control functions. The UPS shall be provided with a pushbutton to trip the breaker from the control panel.

H. Battery Plant:

1. Modular battery cabinets shall be matching and adjacent to UPS cabinet.
2. Modular construction shall be made up of redundant strings per cabinet.
3. Modular battery shall allow a trained user to quickly replace the battery modules during maintenance operation.
4. Each battery string shall be monitored for voltage and temperature for use by the UPS battery diagnostics.
5. UPS shall alarm user when redundant battery string needs replacement.
6. UPS shall incorporate a battery capacity test capable of determining available runtimes.
7. The battery pack shall consist of sealed, valve regulated batteries and a properly rated circuit breaker for isolating the battery pack from the UPS. The battery cells and disconnect breaker shall be installed and housed in a NEMA 1 cabinet matching the UPS style and design.
8. The battery system shall be sized to support the nominal rated load of the UPS for a minimum of 10 min. The battery system shall provide 100% initial capacity upon delivery.
9. Batteries shall be VRLA, sealed, valve regulated with a one year full warranty and a nine year pro rata warranty under full float operation.

2.5 MODES OF OPERATION

- A. Normal: inverters shall continuously supply power to the critical load. The rectifier/battery charger shall derive power from the AC source and supply DC power to the inverter while simultaneously charging the battery.
- B. Emergency: when the utility AC power has failed, the critical load shall be supplied by the inverter, which, without switching, shall obtain its power from the battery. There shall be no interruption or disturbance to the critical load upon failure or restoration of the utility AC power source. When the UPS is operating on battery, a low battery voltage protection circuit shall be used to monitor the DC bus. The inverter shall be automatically turned off and the battery disconnect switch opened when the battery voltage declines to the minimum value.
- C. Recharge: when the AC power has been restored, the rectifier/battery charger shall power the inverter and simultaneously recharge the battery. This shall be an automatic feature and shall cause no interruption to the critical load. When UPS is operating on AC power supplied by standby generator set the battery charge current shall be reduced to the value set by the generator manufacturer during the start-up process.
- D. Bypass: when the static bypass switch is activated, the load shall be transferred to the alternate AC source without interruption. This shall be accomplished by turning the inverter off. Automatic retransfer, or forward transfer of the load to the UPS shall be accomplished by turning the inverter on. The inverter shall automatically synchronize to the alternate bypass source. Once the two sources are synchronized, the static bypass transfer switch shall automatically forward transfer the load from the bypass AC input source to the UPS inverter output. This shall be accomplished by paralleling the two sources and automatically adjusting the UPS inverter output voltage to match the bypass AC input source during transfer.
- E. Maintenance bypass/test: when the UPS is taken out of service for maintenance or repair, the static bypass switch shall be used to transfer the load to the alternate source without interruption. A manual maintenance bypass switch shall be provided to isolate the UPS inverter output and static bypass transfer switch for maintenance. This shall allow the UPS to be tested or repaired without affecting load operation.
- F. Power conditioner: when the battery is taken out of service for maintenance, it shall be disconnected from the rectifier/battery charger and inverter by means of an battery disconnect. The UPS shall continue to function as specified herein except for power outage protection and dynamic characteristics.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

- A. Install the UPS system in accordance with the manufacturer's instructions.

3.2 BATTERY SYSTEM

- A. Install in accordance with manufacturer's instructions.
- B. Test each string for full load battery support time and provide a certified test report.

3.3 FIELD SERVICE

- A. The UPS system manufacturer shall provide factory trained field service personnel to instruct the Contractor and Owner, to support the installation of the equipment, and to assist in placing the equipment into operation.
- B. This service shall include a minimum of 4 separate visits by the service personnel as follows:
 - 1. Preinstallation coordination meeting with the Contractor, Architect, Engineer, and Owner to coordinate the installation and interconnection of the various pieces of equipment specified herein.
 - 2. For initial checkout of the installation of the UPS system.
 - 3. Post installation start-up and testing assistance and initial instruction and training for operating personnel. This trip shall include service required to checkout the system and demonstrate the complete operation for final acceptance. Start-up and testing shall include:
 - a. A complete no load functional test of the equipment to determine that the equipment has suffered no impairment in performance since factory tests were completed.
 - b. A complete load test including:
 - 1) With each UPS module operating from the AC power source, measure and record the following under no load, 25% load, 75% load, 100% load and 110% load for 5 min and calculate efficiency.
 - a) Input voltage.
 - b) Input frequency.
 - c) Input current.
 - d) Input power factor.
 - e) DC voltage.
 - f) DC current.
 - g) Output voltage.
 - h) Output frequency.
 - i) Output current.
 - j) Output and input kW, including battery charger.
 - 2) Measurements and calculations shall demonstrate that each system performs in accordance with the electrical characteristics specified herein.
 - 4. Record each of the following transient voltage tests:
 - a. 25% load step: 50% to 75% load and return.
 - b. 25% load step: 75% to 100% load and return.
 - c. 40% load step: 0% to 40% load and return.
 - d. 40% load step: 60% to 100% load and return.
 - e. Simulate 3 failures.

5. Measure and record the UPS efficiency, with the battery on float charge and with full load at unity power factor.
6. Operate the UPS system with 100% load for a minimum of 4 h. If any failures occur, the test shall be completely restarted.

END OF SECTION 266140

SECTION 266710 - SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other electrical systems are specified in other Sections of Division 26.
- B. This Section covers surge protective devices (SPDs) for low-voltage, 600 V or less, electrical distribution equipment.
- C. This Section includes responsibilities and obligations in support of the performance verification specified in Section 260090, Electrical Performance Verification.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. IEEE C62.41.1-2002 (R2008).
 - 2. IEEE C62.41.2-2002 (COR 1-2012).
 - 3. North Carolina State Electrical Code-2018.
 - 4. UL 1283-2017.
 - 5. UL 1449-2014 (R2018).
- B. SPDs shall have a 5 year warranty.

PART 2 - PRODUCTS

2.1 SURGE PROTECTIVE DEVICES

- A. General:
 - 1. UL 1449-2014 (R2018) voltage protection rating (VPR) label shall be permanently affixed to the units.
 - 2. Maximum continuous operating voltage (MCOV) shall be greater than 115% of the nominal system operating voltage.
 - 3. Protection modes: for a wye-configured system, devices shall have directly connected suppression elements between line-neutral (L-N), line-ground (L-G), and neutral-ground (N-G). For a delta-configured system, devices shall have suppression elements between line-line (L-L) and line-ground (L-G).
 - 4. Nominal discharge current (in): SPDs applied to the distribution system shall have a 20 kA in rating regardless of their SPD type (including Types 1 and 2) or operating voltage.
 - 5. UL 1449-2014 (R2018) component voltage protection rating shall not exceed the following:

<u>System Voltage</u>	<u>208Y/120</u>	<u>480Y/277</u>
L-N; L-G; N-G	700 V	1200 V
L-L	1200 V	2000 V

- 6. Electrical noise filter: each unit shall include a high performance EMI/RFI noise rejection filter.
- 7. Internal connections: internal components shall be hardwired with connections utilizing low impedance conductors and compression fittings.
- 8. Overcurrent protection: each unit shall be provided with overcurrent protection to provide both thermal overload protection for small magnitude fault current conditions or temporary over voltage

conditions as well as short circuit current protection for high magnitude fault conditions. Each MOV module or element shall be individually fused with 200000 RMS symmetrical AIC internal fuses.

9. Monitoring and Diagnostics:
 - a. SPDs shall be equipped with visible indication of proper connection and operation. Indicator lights shall indicate which phase as well as which module is fully operable.
 - b. SPDs shall be equipped with an audible alarm which shall activate when any one of the surge current modules has reached an end-of-life condition. An alarm on/off switch shall be provided to silence the alarm. The switches and alarm shall be located on the front cover of each enclosure.
 - c. SPDs shall be equipped with contacts for remote annunciation of alarm or trouble.
 - d. SPDs installed at service entrance locations or within switchboards shall be equipped with a transient event counter.
10. Each unit shall incorporate an integral test feature to verify the operational integrity of the unit's monitoring system.

2.2 SYSTEM APPLICATIONS

- A. SPD applications covered under this Section include distribution and branch circuit panelboard locations, , and switchboard assemblies.
- B. SPDs shall be designed and tested for application within IEEE C62.41.1-2002 (R2008) Category C, B, and A environments.
- C. Surge current capacity: the minimum surge current capacity that each unit is capable of withstanding shall be as shown in the following table:

IEEE 62.41-2002 (R2008) <u>Location Category</u>	<u>Application</u>	Minimum Surge Current <u>Per Phase</u>	Minimum Surge Current <u>Per Mode *</u>
C	Service entrance (switchboards, switchgear, MCCs, main entrance)	250 kA	100 kA
B	Distribution and power panelboards	150 kA	50 kA
A	Branch circuit panelboards, MCCs, busways	100 kA	50 kA

*L-G, L-N and N-G (wye system); L-L, L-G (delta system).

- D. SPD type: SPDs installed on the line side of the service entrance disconnect shall be Type 1. SPDs installed on the load side of the service entrance disconnect shall be Type 2.
- E. Panelboard Requirements:
 1. Units shall be designed for IEEE C62.41.1-2002 (R2008) and IEEE C62.41.2-2002 (COR 1-2012) Category B environments.
- F. Switchboard Requirements:
 1. Service entrance and other switchboard SPD units shall be designed for IEEE C62.41.1-2002 (R2008) and IEEE C62.41.2-2002 (COR 1-2012) Category C environments.
 2. Provide a disconnect switch directly ahead of or integral to the suppressor assembly.

3. Monitoring diagnostic features such as indicator lights, trouble alarms, and surge counter shall be mounted on the front of the switchboard.

2.3 MANUFACTURER

- A. Eaton SPD, GE Tranquell, Siemens TPS, or Square D Surgelogic.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install SPDs in accordance with manufacturer's written instructions.
- B. Install SPDs in service entrance equipment.
- C. Provide SPDs for switchboards, distribution panelboards, branch-circuit panelboards, where indicated in the Drawings. SPDs shall be installed integral to electrical distribution equipment by the electrical distribution equipment manufacturer.
 1. Locate SPDs on the load side of the main disconnect device, as close as possible to the phase conductors and ground and neutral bar.
 2. SPDs and integral disconnects shall be installed in switchboards using a direct bus bar connection or cable connection between each bus bar and SPD. Maximum cable lead length between suppressor and bus bar shall not exceed 14".
 3. SPDs shall be integrated within panelboards and shall be direct bus bar mounted.

END OF SECTION 266710

SECTION 270010 – COMMUNICATIONS GENERAL

PART 1 - GENERAL

1.1 DESCRIPTION

- A. These Communications General provisions apply to Section 270500 Communications Pathways and Spaces; Section 271000, Structured Cabling Systems, and to Section 271100, Broadband Cabling Systems.
- B. This Section includes responsibilities and obligations in support of the performance verification specified in Section 270090, Communications Performance Verification.
- C. Refer to the General and Supplementary Conditions and Division 01 for special requirements and conditions which apply to all Sections of Division 27.
- D. It is the intent of these Specifications to create an ANSI/TIA-568-C compliant cabling system to support high-speed data, voice and video applications including IEEE standards based on Fast Ethernet, Gigabit Ethernet and 10 Gigabit Ethernet. System acceptance shall be judged on its ability to perform as such, the successful adherence to the installation instructions of this Specification, and compliance with parts and workmanship warranties.
- E. The work covered by this specification includes the installation of a complete cabling system, including all labor necessary to perform and complete such installation, all materials and equipment incorporated or to be incorporated in such installation, and all services, supervision, consumable items, fees, licenses, facilities, tools, and equipment necessary or used to perform and complete such installation.
- F. These specifications are material, equipment, and performance specifications. Actual installation requirements shall be as indicated on the drawings. Installation details indicated on the drawings shall govern if they differ from the specifications. Contractor is obligated to identify such differences at the time of bid submission.
- G. It is the intent of this Specification that all items under these Sections be engineered, assembled, installed and maintained by, and under the full responsibility of a single Contractor, whether these processes are actually performed by the Contractor or not.
- H. Contractor shall comply with all applicable governmental regulations and with all Federal, State, City, and other applicable codes and ordinances. If the contractor performs any work which is contrary to such regulations, codes, and ordinances, contractor shall make all changes to comply therewith and bear all costs arising there from.
- I. The Work Included is defined by the following and further defined in the drawings and Sections of Division 27.
 - 1. Provide project management and oversight for the installation of a complete structured cabling system.
 - 2. Prepare and submit component documentation shop drawings, outlet labeling drawings, cable pull/termination schedules, cable test results and as built drawings as described within this Specification and per the General Conditions.
 - 3. Preparation of shop drawings, record or as-built drawings, manufacturer cut sheets, and other documentation described herein.

1.2 ABBREVIATIONS AND DEFINITIONS

- A. Abbreviations and Acronyms

1.	A/E:	Architect / Engineer (designer)
2.	ANSI:	American National Standards Institute
3.	AHJ:	Authority Having Jurisdiction
4.	APC:	Angled Physical Connector
5.	BDF:	Building Distribution Frame
6.	BICSI:	Building Industry Consulting Service International
7.	CMP:	Communications Plenum cable
8.	CMR:	Communications Riser cable
9.	DAS:	Distributed Antenna System
10.	ELFEXT:	Equal Level Far End Cross Talk
11.	ER:	Equipment Room
12.	F/UTP:	Foil Screened Unshielded Twisted Pair
13.	FOTP:	Fiber Optic Test Procedure
14.	GHz:	Gigahertz
15.	IDC:	Insulation Displacement Conductor
16.	IDF:	Intermediate Distribution Frame
17.	IT:	Information Technology
18.	ISP:	Inside Plant
19.	LC:	A type of small form factor optical fiber connector
20.	LOMMF:	Laser Optimized Multimode Fiber
21.	MDF:	Main Distribution Frame
22.	MHz:	Megahertz
23.	MMF:	Multimode Fiber
24.	MPO:	Multi-fiber Push On connector
25.	MPOE:	Minimum Point of Entry
26.	MTER:	Main Telecommunications Equipment Room
27.	NEXT:	Near End Cross Talk
28.	OFNP:	Optical Fiber nonconductive plenum cable
29.	OFNR:	Optical Fiber nonconductive riser cable
30.	OSP:	Outside Plant
31.	OTDR:	Optical Time Domain Reflectometer
32.	PoE:	Power-over-Ethernet
33.	PSELFEXT:	Power Sum Equal Level far End Cross Talk
34.	PSNEXT:	Power Sum Near End Cross Talk
35.	RCDD:	Registered Communications Distribution Designer
36.	RMU:	Rack Mount Unit
37.	RoHS:	Restriction of Hazardous Substances
38.	ScTP:	Screened Twisted Pair
39.	STP:	Shielded Twisted Pair
40.	SMF:	Singlemode Fiber
41.	TCIM:	Telecommunication Cabling Installation Manual
42.	TDMM:	Telecommunications Distribution Methods Manual
43.	TDR:	Time Domain Reflectometer
44.	TGB:	Telecommunications Grounding Busbar
45.	TIA:	Telecommunications Industry Association
46.	TMGB:	Telecommunications Main Grounding Busbar
47.	TR:	Telecommunications Room
48.	TSER:	Telecommunications Service Entry Room
49.	UL:	Underwriters Laboratory
50.	UTP:	Unshielded Twisted Pair
51.	WAP:	Wireless Access Point

- B. "PROVIDE" or "FURNISH" means to supply, purchase, transport, place, erect, connect, label, test and turn over to Owner, complete and ready for regular operation, all materials, labor, equipment, testing apparatus,

controls, tests, accessories and all other items customarily required for a telecommunications cabling system.

- C. "SUPPLY" means to purchase, procure, acquire, and deliver complete with related accessories.
- D. "INSTALL" means to move from property line, set in place, join, unite, fasten, link, attach, set up or otherwise connect together before testing and turning over to Owner of equipment and/or components. It means the installation is to be complete and ready for regular operation, except as otherwise noted.
- E. "WIRING" or "CABLING" includes furnishing, unless otherwise noted, of all fittings, hangers, supports, sleeves, etc.
- F. "CONDUIT" and CABLE TRAY" includes furnishing, unless otherwise noted, of all fittings, hangers, supports, sleeves, etc.
- G. "AS DIRECTED" means as instructed by the Project Manager or his representative.
- H. "CONCEALED" means embedded in masonry or other construction, installed behind wall furring or within double partitions, or installed within hung ceilings.
- I. "EXPOSED" means not installed underground or "CONCEALED" as defined above.
- J. "PERMANENT LINK" means the end-to-end test configuration for a link excluding test cords and patch cords, but including the mated connection with the link.

1.3 QUALITY ASSURANCE

- A. All products, services and materials provided and performed under the scope of this specification shall conform to the following codes and standards. Refer to the most recent version, update or addenda:
 - 1. North Carolina State Electrical Code - 2018
 - 2. ANSI/TIA-568.1-D, Commercial Building Telecommunications Cabling Standard
 - 3. ANSI/TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standard
 - 4. ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard
 - 5. ANSI/TIA-569-D-1, Commercial Building Standards for Telecommunications Pathways and Spaces
 - 6. ANSI/TIA-606-C, Administration Standard for Telecommunications Infrastructure
 - 7. ANSI/TIA-607-C, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
 - 8. ANSI/TIA-862-A Building Automation Systems Cabling Standard
 - 9. ANSI/TIA-942-A, Telecommunications Infrastructure for Data Centers
 - 10. FCC Part 15
 - 11. FCC Part 68
 - 12. IEEE 802.3ab, 1000Base-T Ethernet Specification
 - 13. IEEE 802.3af Power over Ethernet (PoE) Standard
 - 14. IEEE 802.3at Power over Ethernet+ (Plus) Standard
 - 15. IEEE 802.3an Physical Layer and Management Parameters for 10 Gbps Operation Type 10GBASE-T.
 - 16. IEEE 802.3ba Media Access Control Parameters, Physical Layers and Management Parameters for 40 Gbps and 100 Gbps Operation.
 - 17. IEEE 802.11, Wireless Ethernet Specifications, including 802.11a, 802.11b, 802.11g, 802.11n and 802.11ac.
 - 18. IEEE 802.12, 100Base-TX Ethernet
 - 19. NEC Article 770, Optical Fiber Cables

20. NEC Article 800, Communications Circuits
 21. NFPA 70, National Electrical Code
 22. NFPA 75, Protection of Electronic Computer / Data Processing Equipment
 23. NFPA 101, Life Safety Code.
 24. Underwriters Laboratories Inc. (UL) – Fire Resistance Directory
 25. ASTM E 84, Surface Burning Characteristics of Building Materials.
 26. ASTM E 119, Fire Tests of Building Construction and Materials.
 27. ASTM E 814, Fire Tests of Penetration Firestop Systems.
 28. ANSI/UL263, Fire Tests of Building Construction and Materials.
 29. ANSI/UL723, Surface Burning Characteristics of Building Materials.
 30. ANSI/UL1479, Fire Tests of Through Penetration Firestops.
- B. Provision of manufactured components, installation, wiring and testing shall be the responsibility of a single Contractor.
- C. Supply only new equipment, parts and material currently manufactured at the time of submittal, and operate only for testing as part of installation procedure. Equipment and materials of the same type shall be a product of the same manufacturer throughout unless specifically exempted in advance. A specific example is all products comprising the Permanent Link (station cable, patch panels, jacks, faceplates, etc.). All equipment shall be equal to or exceed the minimum requirements of OSHA, NEMA, IEEE, ASME, ANSI, NEC and Underwriters Laboratories.
- D. Conduit sizes specified herein or indicated on the Drawings refer to the standard trade sizes, are for identification purposes only, and are not actual dimensions.
- E. Codes, standards and regulations referred to are minimum standards. Where the requirements of these specifications or drawings exceed those of the codes, standards and regulations, the drawings or specifications govern. Local electrical and building codes in North Carolina may be more stringent than national codes, recommendations or practice. Follow the most restrictive code or recommendations.
- F. Adhesives and Sealants:
1. Adhesives, sealants, and sealant primers used inside the building (defined as inside the weatherproofing envelope and applied on site) shall comply with SCAQMD Rule 1168-2005 for volatile organic compound content limits.
 2. Aerosol adhesives shall comply with GS 36-2013 for volatile organic compound content limits.
- G. Paints and Coatings:
1. Anticorrosive and antirust paints applied to interior ferrous metal shall not exceed a volatile organic compound content limit of 250 g/L per GS 11-2015.
- H. Component manufacturer shall be ISO 9001:2008 certified and offer products that are RoHS compliant.
- I. Prior to conducting any transmission testing, the following visual inspections will be performed:
1. Verify that all cable has been installed to full compliance with the specifications.
 2. Check for physical damage to the copper and optical fiber distribution panels and termination hardware.
 3. Check that all cabling is properly jacketed, installation properly labeled at both ends of the cable, innerduct and termination hardware is completed in all Telecom Rooms and Equipment Rooms.
 4. Verify that all cable bends are within the manufacturer's specified bend radius.
 5. Verify that all cabinets and racks (which require grounding) are properly grounded and comply with the National and Local Electrical Codes for grounding.
 6. Verify that the cables are properly approved and structurally supported for termination.
 7. Verify that the requirements of all authorities having jurisdiction have been satisfied.

1.4 VENDOR QUALIFICATIONS

- A. The Owner seeks to identify a qualified low voltage communications cabling contractor capable of performing the scope of work as identified in the Contract Documents.
- B. Structured cabling system installer shall currently be a manufacturer's certified system installer in good standing and a certified installer at the Critical Infrastructure Protection (CIP) Level with five years minimum experience on projects similar in scope to that shown on the Drawings and specified herein. Installation crew shall have a minimum of 1 BICSI certified Level 1 installer and 1 BICSI certified Level 2 installer per every 3 personnel, and system installation shall be managed by a registered communications distribution designer (RCDD). Submittal shop drawings shall have the RCDD registration stamp on each sheet.
- C. Craft personnel shall be BICSI certified personnel qualified to perform the work and be knowledgeable of the following activities.
 - 1. Color coding of standard American telephone/ data telecommunications cables.
 - 2. Bonding and grounding of shields.
 - 3. Testing conductors for transmission impairments.
 - 4. Testing conductor insulation.
 - 5. Installation and termination of optical fiber cabling.
 - 6. Testing and verification of optical fiber transmission characteristics with a power meter.
 - 7. Telephone and Data Industry Cable Installation Standards and Manufacturer's Instructions will be used for in-process quality control and final acceptance of the work installation.
 - 8. Cable tray and ladder rack installation.
- D. Craft personnel will be required to provide and use the proper tools and test equipment in the performance of each activity. The tools must be in good working order, and the test equipment must have current calibration certificates, as applicable. The Owner reserves the right to review the tool and test equipment lists and maintenance procedures of the contractor.
- E. The Contractor represents that he/she is familiar with and has expertise in the Work of this nature and scope. The Contractor further agrees that he/she shall provide all Work as may be required to make a complete job of that which may not be fully defined in the Contract documents.

1.5 WARRANTY

- A. Equipment shall be free of faulty workmanship and defects for a period of 1 year from date of substantial completion, and as specified in General Conditions.
- B. Replace defective materials and repair faulty workmanship within three days of notification at no cost to the Owner during warranty period.
- C. In addition to warranty, provide maintenance service for the warranty period, including at least 2 semi-annual visits to site for checking and adjustment of equipment. During this period, answer service calls within 24 hours. During this period, maintenance calls shall be completed within three days of notification and at no cost to the Owner.
- D. Manufacturer's Extended Warranty
- F. All manufacturer extended product warranties shall be afforded to The Owner. A copy of certification by the manufacturer for all products listed in this specification is to be provided.
- G. Provide a 20-year minimum product warranty and system assurance warranty for this cabling system covering hardware and labor to replace any channel that fails the performance requirements specified herein

within the warranty period. Provide cabling and connector products from manufacturers who either manufacture both cable and terminating hardware, or have partnered with other manufacturers to provide such an extended warranty.

- H. Prior to commencement of the work, the successful bidder shall contact an authorized manufacturer's representative to inform them that this job is being registered under the warranty program.
- I. Upon completion of the work, the contractor shall coordinate with the manufacturer the issuance of a full warranty on the entire copper and fiber optic cable plant including the horizontal cabling for both parts and labor. The cabling contractor at his sole expense will correct any deficiencies determined by the manufacturer.

1.6 SUBMITTALS

A. Submittal Procedures

1. Within 14 days after notice to proceed, submit an anticipated Project Schedule, and a schedule indicating the proposed submission date of each submittal specified herein. Schedule shall anticipate the submittal review time, the possible need for resubmittals, and the time required for fabrication, shipping and integration into the construction sequence. Architect and/or Engineer will advise of any conflicts in reviewing submittals that the proposed schedule presents.
2. Submittals shall be prepared in a line-by-line format corresponding to these Specifications and shall indicate compliance with each requirement specified herein and indicated in the Drawings.
3. In addition to any other transmittal or cover sheet used, fill out and attach to each individual submittal a copy of the Cover Sheet for Submittals to Newcomb & Boyd included at the end of this Section.
4. Resubmittals that are required to address review comments shall include a cover transmittal with a written explanation of how each review comment has been addressed.
5. Submittal data for each Specification Section shall be submitted as a single package.
6. Submittals not specifically required, or not complying with the format requirements, will be returned unreviewed.
7. All submittals shall be submitted electronically in PDF format unless stated otherwise.
8. Submittals are required before installation begins. Equipment shall not be ordered, and pay requests will not be approved prior to receipt and approval of submittals.

B. Product Submittals

1. Product submittals shall include all equipment, materials and cables being utilized on the project.
2. Data sheets shall clearly indicate the specific model or part number being submitted for review including sizes, color, finishes, and other attributes to adequately allow submitted product to be reviewed.
3. All related system components shall be submitted as part of the same submission (i.e. patch panels, jacks, faceplates, cable, etc.)
4. Indicate manufacturer's installation instructions, where applicable, including any deviations required due to project conditions.
5. Furnish sample products as required for review by Engineer and/or Architect including any assembly mockups.

C. Shop Drawing Submittals

1. Reproductions or electronic versions of design drawings shall not be used in the preparation of shop drawings.
2. Wiring diagrams indicating proposed connections of equipment, equipment types, model numbers, and designations for cables and termination points.
3. Floor plans indicating equipment locations including equipment identification and references to wiring details.

4. Major, coordinated conduit and cable tray pathways.
5. Shop drawings of fabricated or modified units, if any.
6. Description of labeling methods (including the label scheme and method of attachment) and specific labels being used for cable and outlets.
7. Separate one-line diagrams indicating the proposed backbone distribution, and the horizontal distribution (typically one diagram for each outlet type).
8. Elevations of equipment racks, cabinets, and telephone backboards indicating equipment placement.
9. Detailed coordinated layouts of communications rooms at 1/4" = 1'-0" scale indicating each component drawn to scale, including coordinated power connections, lighting, HVAC, and other trades' equipment such as security panels, paging, fire alarm panels, and service provider equipment.

D. Certificates and Qualifications Submittals

1. Submit management and installation team reference documentation verifying that:
 - a. The project manager is a RCDD in good standing with BICSI and is qualified to manage the scope of work described in the contract documents and has five (5) years of experience managing similar projects in size and scope. The documentation shall include the RCDD registration number.
 - b. The field supervisor is a BICSI trained technician that is qualified to perform and oversee the work described in the contract documents.
 - c. The Contractor is certified by the manufacturer of the Structured Cabling System being installed and is authorized to issue a manufacturer's warranty for the installed solution.
2. The contractor shall submit documentation that within the past 12 months, a minimum of 75% of all installation personnel have been trained or certified by the manufacturer of the products they are installing.
3. A copy of the calibration certificate for all field-test instruments indicating that the tester has been calibrated within the calibration period recommended by the manufacturer.

J. Closeout Submittals

- K. Contractor to submit all cable test results (fiber, copper, coax) and any test documentation required prior to acceptance by the Owner as required in Specification Section 270090, Communications Performance Verification
- L. Subsequent to the installation, and prior to acceptance of the work, the contractor shall prepare and issue record (as-built) drawings, in Adobe PDF and BIM format, that reflect the lengths of cables installed, the actual manner and conditions of installation, including all deletions from, additions to or departures from the contract documents. These documents are to include the information outlet station numbers and cable routing where it varies from the original plan.
- M. Provide revised cable termination schedules for all cables installed under the Work. Schedules shall be in printed form and on CD in Microsoft Excel format.
- N. Provide Operation and Maintenance Manuals including wiring diagrams, parts list, shop drawings and manufacturers' information on all equipment and cables provided under this Work. Provide manuals within fifteen days of systems acceptance.
- O. Upon completion of the work, the contractor shall coordinate with the manufacturer the issuance of a full warranty on the entire copper and fiber optic cable plant including the horizontal cabling for both parts and labor. The cabling contractor at his sole expense will correct any deficiencies determined by the manufacturer.

1.7 SPACE CONDITIONS

- A. Verify dimensions of equipment, equipment arrangements, space availability (including any millwork or cabinetry provided by others) and provide systems that work within the constraints of the space available. Notify the Architect and/or Engineer of any situation where space constraints are a problem, prior to the ordering or purchase of equipment. The Contractor shall bear the expense of providing alternate equipment which will work within the available space, if space availability problems are discovered after equipment is ordered.
- B. Drawings are diagrammatic in nature and, unless explicitly dimensioned, indicate approximate locations of equipment and components. Changes in the location, and offsets, of same which are not shown on the Drawings but are necessary in order to accommodate building conditions and coordination with the work of other trades, shall be made during the production of shop drawings and prior to initial installation, without additional cost to the Owner.
- C. Refer to additional Coordination requirements listed in Division 01
- D. Provide access to equipment and components requiring operation, service or maintenance within the life of the system.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Systems or equipment installed in environmentally controlled areas shall meet performance requirements specified herein in the following conditions:
 - 1. Temperature: 40°F to 95°F.
 - 2. Humidity: 20% to 80% RH.
 - 3. Air purity: systems shall be capable of continuous operation in an environment where the level of dust, lint, paper fiber, and other airborne particles is equal to that found in a standard office.
- B. Systems or equipment installed in indoor environmentally uncontrolled areas shall meet performance requirements specified herein in the following conditions:
 - 1. Temperature: 0°F to 120°F.
 - 2. Humidity: 5% to 95% RH.
- C. Systems or equipment installed in outdoor areas shall meet performance requirements specified herein in the following conditions:
 - 1. Wind-driven dust, dirt, sand, and snow for 6 hours.
 - 2. Rain at a maximum rate of 4" per hour.
 - 3. Ice loads up to 2" measured radially to exposed surfaces.
 - 4. Wind: 85 mph, maximum.
 - 5. Sleet with wind: 55 mph, maximum.
 - 6. Snow cover: 2' maximum, measured vertically.
 - 7. Humidity: 0% to 100% RH.
 - 8. Temperature: -30°F to 150°F.

1.9 SEPARATION FROM EMI SOURCES

- 1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
- 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

- a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

1.10 SEISMIC AND WIND PERFORMANCE

- A. Seismic force design shall be determined in accordance with the following seismic design criteria:
 1. Tower
 2. Seismic Design Category: C.
 3. Risk Category: II.
 4. Component Importance Factor, I_p : 1.0.
 5. E.O.C.
 6. Seismic Design Category: D.
 7. Risk Category: IV.
 8. Component Importance Factor, I_p : 1.5.
- B. Provide restraints devices as required for vibration isolated and non-vibration isolated systems and equipment components. Provide calculations to determine restraint loadings for specific equipment to be installed resulting from seismic forces on equipment. Seismic restraint calculations shall be signed by a licensed engineer in the employ of the seismic restraint device manufacturer.
- C. For roof-mounted equipment and components, both the seismic acceleration and wind loads shall be calculated, and the highest load shall be utilized for the design of the seismic restraints and vibration isolators.
- D. Exceptions for components listed within the applicable project building code may be utilized. However, use of exceptions shall be noted with submitted seismic restraint calculations.
- E. Floor-Mounted Restraints:
 1. Restraints for neoprene vibrations isolators shall consist of Type DN isolators with the addition of welded steel housings to resist seismic forces.
 2. Manufacturer: Kinetics Noise Control, Mason Industries, or VMC Group, Vibration Eliminator, or Vibro-Acoustics.
- F. Suspended Restraints:

1. Restraints for vibration isolated suspended systems or equipment shall consist of galvanized or stainless steel aircraft cables with end connection fittings designed to swivel in order to ensure proper cable alignment and avoid bending of cable.
2. Restraints for non-vibration isolated suspended equipment or raceways shall consist of steel angle or unistrut with anchor bolts and end connection fittings designed to swivel to the final installation angle.
3. Manufacturer: International Seismic Application Technology, Kinetics Noise Control, Mason Industries, Tolco, or VMC Group, Vibration Eliminator, or Vibro-Acoustics.

1.11 LABELING AND IDENTIFICATION

A. General Requirements

1. The labeling scheme is intended to comply with the ANSI/TIA-606-C and the owner's standard for labeling and administration of a cable plant. It is the responsibility of the contractor to acquire, understand, and utilize the owner's labeling scheme for all components of the voice data communications system. The final labeling scheme and all other label requirements shall be coordinated and confirmed with the Owner and Engineer.
2. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
3. Install identifying devices before installing acoustical ceilings and similar concealment.
4. Verify identity of each item before installing identification products.
5. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
6. Apply identification devices to surfaces that require finish after completing finish work.
7. Install signs with approved legend to facilitate proper identification, operation, and maintenance of communications systems and connected items.
8. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

B. Performance Requirements

1. Comply with NFPA 70 and ANSI/TIA 606-C.
2. Comply with ANSI Z535.4 for safety signs and labels.
3. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

C. Cable Label Requirements

1. Indoor Cabling: Self-Adhesive Wraparound Labels – Preprinted flexible labels with acrylic pressure-sensitive adhesive.
2. Outdoor Cabling: Self-Laminating Wraparound Labels – Preprinted flexible labels with clear self-laminating protective shields over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
3. Labels shall be machine-printed utilizing permanent, waterproof blank ink as recommended by the printer and label manufacturer.
4. Font size shall be no smaller than 3/16" high.
5. Labels shall be placed within 12" of termination point.

D. Equipment Label Requirements

1. Engraved plastic signs are to be secured on all equipment racks, cabinets and enclosures per the project requirements.
2. Signs to be engraved with black letters on white face unless otherwise noted. Font size shall be a minimum of 1"

E. Component Label Requirements

1. Equipment Racks
2. Patch Panels:
3. Faceplates:
4. Backbone Cables:
5. Fiber Enclosures:
6. Wiring Blocks:
7. Grounding Busbars

1.12 OPERATIONS AND MAINTENANCE

- A. These operation and maintenance manual requirements supplement operation and maintenance manual documentation requirements of other Sections of these specifications.
- B. Operation and maintenance documentation shall be submitted in PDF format unless otherwise stated.
- C. The operating and maintenance documentation package shall be submitted as one comprehensive package 3 weeks before systems acceptance testing, and shall be updated, revised and completed during, and at completion of, performance verification.
- D. Documentation shall be type written and shall contain, at a minimum, the following information.
1. Introduction:
 - a. Project name, contractors' and subcontractors' names, addresses, and telephone and facsimile numbers.
 - b. Index.
 2. Operations and Maintenance Documentation Directory:
 - a. Explanation of the identification system used, including lists of systems, equipment and component identifiers and names.
 3. Contact Information:
 - a. Emergency contact information for the warranty period.
 - b. Channel warranty manufacturer contact information for warranty issues.
 4. Emergency Information:
 - a. Information for technical and nontechnical personnel about actions recommended during emergency situations to protect property and to minimize disruption to the building occupants. Emergencies shall, at a minimum, include:
 - 1) Power failure.
 - 2) Heating failure.
 - 3) Cooling failure.
 5. Approved submittals.
 6. Maintenance Manual:
 - a. Descriptions (specifications) of the equipment and components.
 - b. Recommended maintenance procedures and their recommended frequency for this Project.
 - c. Recommended list of spare parts, part numbers, and the place(s) from which they can be obtained.
 - d. Original purchase order number; date of purchase; name, address, and the telephone number of the vendor; and warranty information.
 - e. Manufacturers recommended procedures.

7. Test Reports and Certifications:
 - a. Communications cable horizontal channel test reports.
 - b. Broadband cable test reports.
 - c. Other copper cable test reports.
 - d. Fiber optic cable test reports.
8. Construction Documents:
 - a. Record drawings.
 - b. Warranty certificates.
 - c. Cable test reports.

- E. An electronic copy of construction documents shall be included on CD-ROM within each operation and maintenance binder. Close-out materials provided in electronic format shall include record drawings, approved submittals, warranty certificates, and test reports.
- F. Submit a receipt signed by the Owner acknowledging receipt of the operation and maintenance documentation package.

1.13 RECORD DRAWINGS

- A. Refer to Section 017839, Project Record Documents.
- B. Concurrent with the Architect's final certificate, submit 2 sets of prints indicating field and as-installed conditions of raceways and equipment, and incorporating changes made during construction.
- C. Upon completion of the Project, submit marked-up drawings indicating field and as-installed conditions, and shop drawings incorporating changes made during construction for raceways and equipment. Submit the following:
 1. Full size PDFs on CDs.

1.14 MAINTENANCE

- A. Equipment operated prior to the date of substantial completion shall be maintained in accordance with manufacturers' recommendations.

1.15 INSTRUCTION OF OPERATING PERSONNEL

- A. Conduct formal instruction sessions for operating personnel. Conduct 2 similar sessions. The first session shall be conducted at the time of start-up and check-out, and the second session shall be approximately 2 months later. Sessions shall be conducted at the site.
- B. Prepare and submit a syllabus describing an overview of the program, describing how the program will be conducted, when and where meetings are to be held, names and company affiliations of lecturers, description of contents and outline for each lecture, and recommended reference material and outside reading. Obtain direction from the Owner on which operating personnel shall be instructed in each system.
- C. Sessions shall include:
 1. General familiarization and operating procedures for each specialty systems installation.
 2. Routine maintenance procedures for equipment.
 3. User level programming of programmable systems.
 4. Factory-trained technicians shall give operating and maintenance instructions on the following specialty systems and equipment:

<u>System/Equipment</u>	<u>Minimum Session Duration, Hours</u>
Structured cabling systems	4
5. Provide MP4 format video of training sessions and a complete record copy of training materials, handouts, and other printed materials used in each training session.	
6. Obtain receipt acknowledging completion of each item of instruction.	

PART 2 - PRODUCTS

(not applicable)

PART 3 - EXECUTION

3.1 GENERAL

- A. Install plenum rated cables where cables are not installed in conduits or enclosed wireways.
- B. Install cables designed for the installation environment.
 - 1. For each cable distribution application, install fiber optic and copper cables UL listed for the application.
 - 2. For cable distribution applications including enclosures or raceways underground or in slabs on grade, install fiber optic and copper cables designed for use in wet locations.
- C. Provide incidental equipment or devices to provide a complete and operable system.
- D. Verify correctness of parts lists and equipment model numbers and conformance of each component with manufacturer's specifications.
- E. Equipment shall be installed in accordance with the manufacturer's instructions.
- F. Equipment, except portable equipment, shall be held in place. This shall include equipment, enclosures, components, and cables. Fastenings and supports shall support their loads with a safety factor of at least 3 unless otherwise specified herein.
- G. Prevent and guard against electromagnetic and electrostatic hum and install the equipment to provide safety for the operator.
- H. Repair or replace any equipment or materials damaged during the construction period.
- I. Exposed equipment, equipment supports, and components in the Telecommunications Rooms shall have a flat black finish unless otherwise specified herein.
- J. Keep all items protected before and after installation. Provide protection for exposed cables roughed onto the floor prior to their installation into the furniture systems. Clean up and remove all debris.
- K. If products and materials are specified herein for a specific item or system, use those products or materials. If products and materials are not listed, use first-class products and materials, subject to acceptance of product submittals and shop drawings.

- L. Examine and compare the communications cabling drawings and specifications with the drawings and specifications of other trades; report any discrepancies between them to the Architect and obtain from him written instructions for changes necessary in the work.
- M. The locations of structural and architectural features, existing sleeves, floor slots, termination and cross connect fields, panels, racks and other equipment indicated on the drawings are approximate. The contractor shall verify the existence, locations, and suitability of all such items, and shall present, with bid response, required modifications to contract documents necessary to complete this work.
- N. Contractor shall take all necessary precautions to assure that the maximum tensile load and minimum bend radius of all cables (fiber and copper) are not exceeded. When terminating UTP cable, the contractor must maintain pair twists up to the termination point and the cable sheath shall not be removed more than 0.5" from the termination point. Velcro wraps are to be hand tightened on cables to prevent crimping cable sheath. Plastic tie wraps are not to be used on lateral cables. The contractor is responsible for protecting all connectorized cables from damage by other contractors at the information outlet before and after installation of the outlet faceplates.
- O. Furnish, install, terminate and test all horizontal (station) and backbone cabling for all floors shown in the attached and associated drawings and as described below.
 - 1. The contractor shall route all copper and fiber cabling, unless otherwise identified, via hung ceilings, cable tray, ladder rack, conduits, raised floors, poke-throughs, and furniture systems unless otherwise noted. Contractor shall install all overhead station cable in such a manner that the selected route does not in any way compromise ceiling integrity. Cables that are routed in open ceiling areas must be neatly wrapped with Velcro or hook and loop tape and suspended with the appropriate hangers. Cables shall not be allowed to rest on ducts, pipes and conduits. At no time will cable be supported from hung ceilings or ceiling support wires. All overhead cabling must be neatly bundled and secured as close as possible to the overhead slab to avoid conflict with or EMI from flexible electrical conduits, motors, etc.
 - 2. Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
 - 3. Install plenum cable in environmental air spaces, including plenum ceilings.
 - 4. Fiber optic and copper cables installed in enclosures or raceways underground or in slabs on grade shall be designed for use in wet locations.
 - 5. Comply with requirements for raceways, cable trays and boxes as specified in Section 270500 "Communications Pathways and Spaces"
 - 6. Cable raceways shall not be filled greater than the ANSI/TIA-569-A maximum fill for the particular raceway type or 40%.
 - 7. Horizontal distribution cables shall be bundled in groups of no more than 50 cables for Category 5e and 6, and no more than 24 cables for Category-6A. Cable bundle quantities exceeding these limits may cause deformation of the bottom cables within the bundle and degrade cable performance.
 - 8. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
 - 9. Core drilling and the installation of aftersets, grommets access slots, sleeves, conduits, fire-rated poke-throughs, and raceways required to route copper and fiber optic cabling will be furnished and installed by parties as indicated by contract documents. Where pathways furnished by others are not sufficient for the routing of cabling, this condition shall be brought to the attention of the Architect and/or Engineer in writing, by this contractor.
 - 10. As indicated, cabling shall run to workstation and other outlets through cavities in the drywall and openings in sheet metal or wooden studs within the drywall construction. The sheet metal studs will not be gasketed for this purpose, it shall be the contractor's responsibility to exercise extreme care in snaking cable through these areas to avoid damage to the cable jacketing. This installation method is only approved for installation of cables in existing walls. All new construction shall receive conduit and backbox at each outlet location per the requirements of Section 270050 "Communications Pathways and Spaces" and per the project drawing details.

11. Information Outlet faceplates for all boxes will be furnished and installed by this contractor and match the color and finish of the adjacent power receptacle.
- P. Under no circumstance shall any device be connected to Owner's data network without approval from the Owner. This includes any laptop, PC, network switch, hub, wireless access point, security camera, intercom station, network diagnostic tool, or any other device capable of connecting to the data network.
- Q. IP Addresses for any contractor-installed equipment will be furnished by the Owner. Only devices that have been configured with an Owner provided IP Address, subnet mask, gateway address, DHCP Reservation, etc. may be placed on the network, and only after receiving approval from the Owner.
 1. Requests for IP Addresses shall be made at least 14 days in advance.
 2. Provide Owner with a list of devices requiring IP addresses, including the Serial Number and MAC address of each device.

END OF SECTION 270010

COVER SHEET FOR
SUBMITTALS TO NEWCOMB & BOYD

Project: _____ Date: _____

Item: _____ Submittal Number: _____

Manufacturer: _____ Model: _____

Specification Paragraph and/or Drawing Number: _____

Options Included (if any): _____

Deviations (if any; if none, state so): _____

General Contractor Approval: _____

SECTION 270050 – COMMUNICATIONS PATHWAYS AND SPACES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. These Communications Pathways and Spaces provisions apply to Section 270010 Communications General; Section 271000, Structured Cabling Systems; and to Section 271100, Broadband Cabling Systems.
- B. This Section includes responsibilities and obligations in support of the performance verification specified in Section 270090, Communications Performance Verification.
- C. The communications systems contractor shall be responsible for interfacing power and grounding provisions with work provided under these Sections.
- D. Refer to the General and Supplementary Conditions and Division 01 for special requirements and conditions which apply to all Sections of Division 27.

PART 2 - PRODUCTS

2.1 UNDERGROUND DUCTS, MANHOLES, AND HANDHOLES

- A. Underground ducts, manholes, and handholes shall be in accordance with Section 261150, Underground Ducts, Manholes, and Handholes.

2.2 EXCAVATION AND BACKFILLING

- A. Excavation and Backfill: Comply with Division 31 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

2.3 INNERDUCT

A. Textile Innerduct

- 1. Standard Outdoor Textile Innerduct: Micro, 2-inch, 3-inch and 4-inch single or multi-cell polyester/nylon textile innerduct containing 1250lb polyester flat woven pull tape.
- 2. Indoor Textile Innerduct (Riser-listed): Micro, 2-inch, 3-inch and 4-inch single or multi-cell nylon textile innerduct containing 1250lb polyester flat woven pull tape which meets UL2024A for flame propagation and smoke density values for general applications.
- 3. Plenum-Listed Textile Innerduct: Micro, 2-inch and 3-inch single or multi-cell nylon textile innerduct containing 200lb nylon-resin flat woven pull tape which meets UL2024A for flame propagation and smoke density values for use in air handling spaces.
- 4. Each innerduct shall be installed with unique color striping, and multi-colored pull tapes.

B. Textile Innerduct Fittings

- 1. Conduit Plugs: Compression-type conduit plugs with locking nuts for sealing and securing one or more textile innerducts within a 4-inch inside diameter conduit, e.g.:4-inch plg with nine holes for cables in a 3 pack (9-cell) configuration
- 2. Termination Bags: Inflation-type bags for sealing and securing around one or more textile innerducts and cables within 2-inch outside diameter or larger conduit.

C. Pull Tape

1. Measuring and pulling tape constructed of synthetic fiber, printed with accurate sequential footage marks. Color-coded.

D. Penetration Sealing Material

1. Duct Water Seal: products suitable for closing underground and entrance conduit openings where innerduct or cable is installed, to prevent entry of gases, liquids, or rodents into the structure.

2.4 EQUIPMENT RACKS

A. General

1. Racks designed for mounting telecommunications equipment.
2. Refer to Specification Section 270051 for Server Cabinet requirements.
3. Width is compatible with EIA-310-E, 19-inch equipment mounting with an opening of 17.72-inches between rails.
4. Manufacturers:
 - a. Chatsworth Products, Inc.
 - b. nVent (Hoffman)
 - c. Eaton (B-Line)
 - d. Great Lakes
 - e. Panduit
 - f. Approved Equal

B. 2-Post Equipment Racks

1. Base shall have a minimum of four mounting holes for permanent attachment to floor.
2. Top shall have provisions for attaching to cable tray or ceiling.
3. Integrated Ground Studs
4. Load Rating: 1,000 pounds minimum
5. Material: Extruded Aluminum
6. Color: Black
7. Overall Height (Rack Spaces): 7' (45U)
8. Upright Depth: 3-inches
9. Threads: 12-24

C. Cable Management

1. General
 - a. Metal, with integral wire retaining fingers.
 - b. Baked-polyester powder coat finish.
 - c. Products shall be from the same manufacturer as 2-post and 4-post racks and/or cabinets unless otherwise indicated on drawings.
2. Vertical Cable Management for 2-Post and 4-Post Racks
 - a. Vertical cable management panels shall have front and rear channels (double-sided), with hinged, removable covers.
 - b. Vertical cable management panels shall be the same height as the 2-post and 4-post racks.
 - c. Width of Vertical cable management panels shall be as indicated on the drawings, but no smaller than 6" wide unless specifically noted on the drawings.
3. Horizontal Cable Management
 - a. Provide horizontal crossover cable manager at top of each relay rack, with a minimum height of two rack units each.

- b. Ring depth and mounting rail adjustment shall be coordinated in wall-mount cabinets.
 - c. Style: Single-sided solid
 - d. Ring Depth: 3.5"
- D. Height: 1U or 2U as indicated.
- E. Accessories
 - 1. Vertical Grounding Bar: Provide one for each 2-Post and 4-Post Rack.
 - 2. Rack Shelves:
 - a. Fixed Shelf for 2-Post Rack
 - 1) Single-Sided
 - 2) Solid
 - 3) 15" deep
 - b. Fixed Shelf for 4-Post Rack / Server Cabinet
 - 1) 1U, Adjustable Depth, vented
 - c. Provide one for each 2-Post and 4-Post Rack.
 - 3. Cage Nuts:
 - a. Size: 12-24
 - b. Provide 100 Cage Nuts and Screws for each rack or cabinet with square-punched rails.
 - 4. Mounting Screws:
 - a. Provide 100 mounting screws for each rack or cabinet of the same size as the mounting rail threads.

2.5 PLYWOOD BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, A-C grade, Void free, 3/4 by 48 by 96 inches.
- B. Backboard Paint: Light-colored fire-retardant interior latex paint.

2.6 CABLE RUNWAY (LADDER RACK)

- A. Cable Runways:
 - 1. Cable runways shall form a wireway system for cable management inside communications rooms. Constructed of steel tubing with 12-inch rung spacing.
 - 2. Runways shall be classified by UL and rated as an equipment grounding conductor.
 - 3. Runways shall have 0.375" x 1.5" stringers rated for 42 lb/ft at L/360 when supported at 6' intervals.
 - 4. Open rung ladder type cable tray with runway dropouts, complete with splice hardware, runway termination hardware, and 5/8-inch ceiling support hardware.
 - 5. Size: 18" wide unless otherwise indicated on drawings.
 - 6. Color: Black
 - 7. Manufacturers:
 - a. Chatsworth Products, Inc (CPI)
 - b. Eaton B-Line
 - c. Approved Equal
- B. Cable Runway Accessories

1. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable runway.
2. Barrier Strips: Same materials and finishes as for cable tray.
3. Cable runway supports and connectors, including bonding jumpers, as recommended by cable runway manufacturer. Furnish and install Seismic Bracing as required.
4. Specific Accessory Products: Furnish and install all accessories, including but not limited to radius drops, splice kits, support kits, end closing kits, protective end caps, ground wire supports, elevation kits, and other accessories as indicated on the project drawings, and as required for a complete cable runway system.

2.7 NON-CONTINUOUS CABLE SUPPORTS

- A. Non-continuous cable supports shall be available in multiple sizes, styles and materials. Rigid supports shall be equipped with flared edges and pre-configured bend radius controls.
- B. Provide drop wire supports and threaded rod assemblies in areas where structural mounting surfaces are non-functional or inaccessible.
- C. Sling assemblies/cable straps shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance UTP and optical fiber cables. Support slings shall have a static load limit of 100 lbs.
- D. Non-continuous cable supports sized 1 5/16" and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable.
- E. Select approved non-continuous cable supports suitable for specific installation environments and/or air handling (plenum) spaces.
- F. Multi-Tier Assembly
 1. Utilize manufacturer hardware to allow for multiple tiers of cable supports as indicated on the project drawings.
 2. Continuous cable division shall be fully maintained within each open top cable support.
- G. Manufacturers:
 1. Erico CAT HP & 425 Series
 2. MonoSystems
 3. Approved Equal

2.8 RACEWAYS, CABLE TRAYS, AND BOXES

- A. Raceways, cable trays, and boxes shall be in accordance with Section 261100, Raceways, Section 261120, Cable Trays, and Section 261300, Boxes.

2.9 SLEEVES AND FIRESTOPPING

- A. Firestops
 1. Firestops shall consist of an asbestos-free fill material, forming/backing/damming materials, and accessories needed to complete a UL classified through-penetration firestopping system. Fill material shall not slump or sag and shall be the required thickness in the fully cured state.
 2. Firestops shall be designed to seal through-penetrations against flame, heat, smoke, and water in compliance with ASTM E84-2016, ASTM E119-2016a, ASTM E814-2013a, UL 723-2008, and UL 1479.

3. Firestops shall be specifically designed and rated for the individual application, including movement, materials, moisture, penetrating item material, and fire and smoke ratings of the penetrated construction.
4. Manufacturers:
 - a. 3M
 - b. GE
 - c. Flammadur
 - d. Hilti
 - e. Nelson
 - f. Rectorseal
 - g. Thomas & Betts.

B. Firestopped Sleeve Assemblies

- C. Provide an enclosed fire rated cable management device whenever cable bundles penetrate fire rated walls. The cable management device shall contain integrated intumescent firestop wrap strip materials sufficient to maintain the hourly rating of the barrier being penetrated. The cable management device shall contain a smoke seal fabric membrane or intumescent firestop plugs sufficient to achieve the L-Rating requirements of the barrier type.

- D. Provide non-curing, re-penetrable, intumescent firestop materials around communications cable trays or ladder racks penetrating through a fire rated wall. The firestop system assembly shall be able accessible and re-installed from one side of the wall. The firestop material shall allow up to 12" of unreinforced annular space.

- E. UL classified for use in wall and floor systems rated for up to 3 hours.

F. Manufacturers:

1. Abesco Fire Ltd. - Cable Transit System
2. Specified Technologies, Inc. - EZ-Path
3. Legrand – FlameStopper
4. Hilti Speed Sleeve

2.10 GROUNDING AND BONDING

A. General

1. Comply with UL 467 for grounding and bonding materials and equipment.
2. Comply with ANSI/TIA-607-C - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
3. Manufacturers:
 - a. Chatsworth Products, Inc.
 - b. Eaton B-Line
 - c. Panduit

B. Grounding Busbars

1. Telecommunications Main Grounding Busbar (TMGB)
 - a. Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with ANSI/TIA-607-C.
 - b. Predrilling shall be with holes for use with lugs specified in this Section.

- c. Mounting Hardware: Stand-off brackets that provide a 4-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
 2. Telecommunications Grounding Busbar (TGB)
 - a. Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with ANSI/TIA-607-C.
 - b. Predrilling shall be with holes for use with lugs specified in this Section.
 - c. Mounting Hardware: Stand-off brackets that provide at least a 2-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
 3. Rack and Cabinet Grounding Busbars
 - a. Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with ANSI/TIA-607-C. Predrilling shall be with holes for use with lugs specified in this Section.
 - 1) Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
 - 2) Rack-Mounted Horizontal Busbar: Designed for mounting in 19-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
 - 3) Rack-Mounted Vertical Busbar: 72-inches long, with stainless-steel or copper-plated hardware for attachment to the rack.

C. Conductors

1. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.
2. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
3. Cable Tray Grounding Jumper: Not smaller than No. 6 AWG and not longer than 12 inches. If jumper is a wire, it shall have a crimped grounding lug with two holes and long barrel for two crimps. If jumper is a flexible braid, it shall have a one-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.

D. Connectors

1. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.
2. Busbar Connectors: Cast silicon bronze, solderless compression-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.

2.11 POWER PROTECTION (UPS & Power Strips)

A. General

1. System shall be a self-contained unit designed for the support of IT equipment.
2. Refer to Section 270051 for Server Cabinet PDU requirements.

B. Batteries: lead-calcium, lead-acid, or nickel-cadmium type.

C. Integral lightning and surge protection complying with IEEE C62.41.1-2002 (R2008), IEEE C62.41.2-2002 (COR 1-2012), and UL 1449-2014.

D. Uninterruptable Power Supply (UPS)

1. UPS Location: Comm Room 132, 218, 317, 418
2. Architecture: Double-conversion
3. Load: 4000VA
4. Input Voltage: 208V
5. Input Plug: L6-30P
6. Output Voltage: 120V
7. Output Receptacles: NEMA L5-20R
8. Runtime at Full Load: 15 minutes
9. Form Factor: Rack-Mount
10. Network Management Card
11. Environmental Monitoring Card
12. Rack-Mount Step Down Transformer as required for output receptacle requirements.
13. Manufacturers
 - a. Schneider Electric (APC)
 - b. No substitutions

E. Rack Mount Power Strips / PDU

1. Vertical Surge-Protected Power Strips
 - a. Input Plug: NEMA L5-20P
 - b. Input Cord Length: 10 feet
 - c. Output: NEMA (24) 5-20R
 - d. Metered: LED Display indicating Voltage and Amps
 - e. Provide one vertical power strip for each 2-post and 4-post rack.
 - f. Provide all mounting hardware and standoff brackets as required.
 - g. Manufacturer:
 - 1) Chatsworth Products, Inc. (CPI)
 - 2) Geist Manufacturing
 - 3) Schneider Electric (APC)
 - 4) Approved Equal

PART 3 - EXECUTION

3.1 UNDERGROUND DUCTS, MANHOLES AND HANDHOLES

- A. Underground ducts, manholes, and handholes shall be in accordance with Section 261150, Underground Ducts, Manholes, and Handholes.

3.2 EXCAVATION AND BACKFILLING

- A. Determine exact location of existing underground utilities before excavation.
- B. Excavation shall be no longer or deeper than necessary. Backfill material shall be free from rocks and debris.
- C. Compact backfill as the excavation is filled.
- D. Excavation, shoring, bracing, backfilling, and compaction, cutting and patching of hardscape, and restoration of landscape shall conform to Division 31, Earthwork.

3.3 INNERDUCT

A. General

1. Protect products from the effects of moisture, UV exposure, corrosion and physical damage during construction.
2. Select approved innerduct suitable for specific installation environments and/or air handling (plenum) spaces.

B. Textile Innerduct Installation

1. Provide in conduit and wire ways using continuous unspliced lengths between maintenance holes, pull boxes, and/or termination points as indicated on the drawings.
2. Provide suitable textile innerduct slack in the maintenance holes, hand holes, pull boxes, and at turns to ensure there is no kinking or binding of the product.
3. Textile Innerduct Mountings, Hangers and Attachments: When exposed indoors or in maintenance holes, hold firmly in place using independent support.
 - a. Design & install hangers and other similar fittings adequate to support loads and so as to not damage innerduct.
 - b. Do not fasten textile innerduct to steam, water, or other piping, ductwork, mechanical equipment, electrical equipment, electrical raceways, or wires
 - c. When appropriate, use the following cable ties to secure textile innerduct through previously created incisions:
 - 1) Plenum areas: plenum-rated plastic or stainless steel
 - 2) Non plenum areas: Conventional flame-retardant nylon ties
 - 3) Underground locations: Conventional plastic cable ties
4. Maintenance Hole and Hand Hole Installation:
 - a. At locations where textile innerduct will be continuous through a manhole or hand hole, allow sufficient slack so that the innerduct may be secured to the side of the vault maintaining the minimum bend radius.
 - b. At maintenance holes serving as the junction location, pull the exposed end of the innerduct to the far end of the vault, install termination bag, and secure to the vault.

C. Penetrations

1. Seal all conduit and textile innerduct entering structures at the first box or outlet to prevent entrance into the structure of gases, liquids or rodents.
2. Inspect fire stopping installation by others between building structure and conduit, wire way, and cable tray to verify integrity of installation.
3. Exposed Textile Innerduct Penetrations: Install conduit sleeves or fire barrier sealing systems in all openings where open and exposed textile innerduct passes through fire-rated walls and floors. After installation, install intumescent fire barrier penetration sealing material between textile innerduct and sleeves or fire barrier system.
4. Raceway Penetrations: After textile innerduct installation, install intumescent fire barrier penetration sealing material between textile innerduct and conduit or wire way at all exposed penetration locations.
5. Protect adjacent surfaces from damage during water seal or fire stop installation. Repair any damage.

3.4 EQUIPMENT RACKS

A. Comply with NECA 1.

- #### B.
- Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

- C. Coordinate layout and installation of communications equipment in racks and room. Coordinate service entrance configuration with service provider.
 - 1. Meet jointly with system providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
 - 2. Record agreements reached in meetings and distribute them to other participants.
 - 3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment spaces to accommodate and optimize configuration and space requirements of telecommunications equipment.
 - 4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.
- D. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.
- E. Equipment Rooms
- F. Remove dust, dirt, rust, stains, and temporary covers.
- G. Foreign matter shall be blown, vacuumed, or cleaned out of and from new equipment, devices, switches, controls, and panels.
- H. Clean and polish identification plates.
- I. In equipment rooms, clean equipment, conduit, and room surfaces from dust and dirt and maintain in a clean condition from date of substantial completion until final completion of work and corrective work.
- J. Remove all excess material from the Project site.

3.5 PLYWOOD BACKBOARDS

- A. Install from 6 inches to 8' 6" feet, 6 inches above finished floor. If plywood is fire rated, ensure that fire-rating stamp is visible after installation.
- B. Paint backboard with two coats of paint.
- C. Plywood to be installed such that the fire-rated stamp along the edge or center of the plywood is visible and can be easily inspected. If plywood is painted, the stamp must remain visible. If the stamp is painted-over, the contractor shall be required to replace and properly repaint the plywood.
- D. Comply with requirements for backboard installation in BICSI's "Information Technology Systems Installation Methods Manual" and TIA-569-D.

3.6 CABLE RUNWAY (LADDER RACK)

- A. Install all cable runway per the manufacturer's recommended installation instructions, as indicated in the project drawings. Follow all mounting and support guidelines.
- B. Provide all components of the cable runway system (cable runway, turns, splices, supports, and accessories) from a single manufacturer.
- C. Cable runway shall be installed with side stringers facing down so that the ladder forms an inverted U-shape.

- D. Cable runway shall be secured to the structural ceiling, building truss system, wall, floor or the tops of equipment racks and/or cabinets using the manufacturer's recommended supports and appropriate installation hardware and methods as defined by local code or the authority having jurisdiction (AHJ).
- E. Cable runway splices will be made in mid-span, not over a support, with the manufacturer's recommended splice hardware.
- F. Cable runway support:
 - 1. Every 5' or less in accordance with TIA-569-D.
 - 2. Within 2' of every splice and within 2' on both/all sides of every intersection.
 - 3. Within 2' on both sides of every change in elevation.
 - 4. Every 2' when attached vertically to a wall.
- G. Heavy-duty splices:
 - 1. Recommended for 18" wide or wider cable runway.
 - 2. Required for any splice formed in the vertical orientation including changes in elevation formed using vertical-to-horizontal 90° turns or horizontal-to-vertical 90° turns.
 - 3. To secure all overhead turns to the overhead horizontal pathway(s).
- H. Clearances:
 - 1. Minimum clearance of 12" above the cable runway.
 - 2. Leave a minimum of 12" in between cable runway and ceiling/building truss structure.
 - 3. Leave a minimum of 3" in between cable runway and the tops of equipment racks and/or cabinets.
 - 4. Minimum clearance of 12" in between each tier of cable runway.
 - 5. When located above an acoustical drop ceiling, leave a minimum of 3" clearance between the top of the drop ceiling tiles and the bottom of the cable runway.
 - 6. When installed under a raised floor, cable runway shall be installed with a minimum 3" clearance between the top of the cable runway and the bottom of the floor tiles or floor system stringers, whichever is lower in elevation. Maintain a 3" clearance between cable runways wherever cable runways cross.
 - 7. Maintain a 2' separation between ladder rack used for communications cables and pathways for other utilities or building services.
- I. Bonding and Grounding
 - 1. Within each telecommunications room, cable runway should be bonded together, electrically continuous, and bonded to the TGB, unless otherwise noted in the specifications and contract documents.
 - 2. Shall be bonded across each splice with a bonding kit or with splices per the manufacturer's installation instructions.
 - 3. Shall be bonded to the Telecommunications Grounding Busbar (TGB) using an approved ground lug on the cable runway and a minimum #6 grounding wire or as recommended by the AHJ.
 - 4. Remove paint from the cable runway where bonding/ground lugs or splices contact the cable runway so that the lug or splice will contact bare metal. Use antioxidant joint compound.
 - 5. Verify continuity through the bonds at splices and intersections between individual cable runway sections and turns and through the bond to the TGB.
- J. Fill Ratio:
 - 1. Not to exceed 50%.
 - 2. Actual cable fill for cable runway that is not equipped with cable retaining posts will not exceed 2" in height.
 - 3. The combined weight of cables within the cable runway will not exceed the stated load capacity of the cable runway as stated in the manufacturer's product specifications or load/design tables.

K. Cable Installation:

1. Cables (cable bundles) will be secured to the cross members of cable runway with 3/4" wide reusable straps.
2. When a single cable runway supports different types of cable media, the cable media will be separated within the pathway by cable spools that attach to the cross members on the cable runway. Treat each type of cable media and divided area of the cable runway separately when determining cable fill limits.
3. Use a radius drop to guide cables to access a rack, frame, cabinet or wall-mounted rack, cabinet or termination field. If necessary, provide a moveable cross member also to attach and align the radius drop in between the welded cross members of a cable runway.
4. Cover the exposed ends of cable runway that do not terminate against a wall, the floor or the ceiling with end caps or an end closing kit.
5. The installer will provide touch-up paint color-matched to the finish on the ladder rack and will correct any minor cosmetic damage (chips, small scratches, etc.) resulting from normal handling during the installation process prior to delivery to the owner. If a component is cosmetically damaged to the extent that correction in the field is obvious against the factory finish, the component will be replaced with a new component finished from the factory. If a component is physically damaged due to mishandling or modification during the installation process, it shall not be used as part of the ladder rack system.

3.7 NON-CONTINUOUS CABLE SUPPORTS

- A. Follow manufacturer's instructions and recommended industry standards and guidelines.
- B. The installed non-continuous support system must be an independent support structure for the voice/data communication system.
- C. Draping cables over other structures in the ceiling is unacceptable. Water pipes, ceiling grid, sprinkler system, electrical supports, air ducts or any other in-ceiling structure may not be used for cable support.
- D. Contractor installed supports shall be used to supplement the main cable support system when any cabling leaves the main support system or is unsupported for more than three and one half feet (3'-6").
- E. Supports shall be installed at a maximum distance of 5'-0" apart.
- F. Non-continuous supports shall be installed with ceiling wire or threaded rod secured to the slab above to support the telecommunications cable infrastructure parallel to the slab throughout the cable plant, unless site conditions dictate a non-parallel installation.
- G. Cable must be routed to follow existing corridors and parallel or 90 degree angles from all walls and the cable tray whenever possible.

3.8 RACEWAYS, CABLE TRAYS, AND BOXES

A. General:

1. Install raceways and boxes in accordance with Section 261100, Raceways, Section 261120, Cable Trays, Section 261300, Boxes, and TIA 569-D-2016.
2. Install wiring or cables in raceways where wiring or cables are installed underground, in concrete, and concealed in walls or in inaccessible ceilings.
3. Install wiring or cables in raceways where wiring or cables are otherwise exposed, including open ceiling spaces.

3.9 SLEEVES AND FIRESTOPPING

A. General

1. Install in accordance with the manufacturer's published instructions to achieve ratings and classifications specified herein. A copy of these instructions shall be maintained and available on site.

B. Provide where cables pass through walls or elevated floor slabs within communications rooms.

C. Provide where cable trays pass through rated walls or elevated floor slabs. Install 4 sleeves at each penetration, minimum.

D. Install associated rating information decal on both sides of sleeve. Sign and date the decal.

E. Install sleeve systems with flanges and fire-rated caulk as recommended by the manufacturer.

F. Sleeve Installation for Non Fire-rated Electrical Penetrations

1. Comply with NECA 1.
2. Comply with NEMA VE 2 for cable tray and cable penetrations.
3. Sleeves shall be secured in place. Provide insulating bushings on both sides of sleeves for cables.
4. Provide ground bushings on both sides of sleeves containing separate ground conductors.
5. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - a. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - 1) Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - 2) Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - b. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - c. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed, or unless seismic criteria require different clearance.
 - d. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 - e. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
 - f. Wall sleeves shall extend 4" from each side of the walls.
 - g. Openings through slabs for communications risers shall be finished with a 4" wide x 2" high curb around the opening.
6. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 - a. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 - b. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
 - c. Wall sleeves shall extend 4" from each side of the walls.
 - d. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

- e. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - f. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between pathway or cable and sleeve for installing sleeve-seal system.
7. Sleeve-Seal System Installation
- a. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.
 - b. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
8. Sleeve-Seal Fitting Installation
- a. Install sleeve-seal fittings in new walls and slabs as they are constructed.
 - b. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
 - c. Secure nailing flanges to concrete forms.
 - d. Using grout, seal the space around outside of sleeve-seal fittings.

G. Firestopping

- 1. Close and firestop penetrations through fire- and smoke-rated construction. Materials used to seal these penetrations shall continue the construction's fire and smoke resistance ratings uninterrupted and shall maintain an effective barrier against the spread of flame, smoke, water and hot gases.
- 2. Install after installation of raceways, and cable trays.

H. Firestopped Sleeve Assemblies

- 1. General: Install through-penetration firestop systems in accordance with Performance Criteria and in accordance with the conditions of testing and classification as specified in the published design.
- 2. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of firestopping products.

3.10 GROUNDING AND BONDING

A. General

- 1. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.
- 2. Comply with NECA 1 and ANSI/TIA-607-C.

B. Conductors

- 1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
- 2. Install without splices.
- 3. Support at not more than 36-inch intervals.
- 4. The bonding conductors between the TGB and/or TMGB, and structural steel of steel-frame buildings, shall not be smaller than No. 6 AWG.
- 5. The bonding conductor between the TMGB and the AC service equipment ground shall not be smaller than No. 3/0 AWG.

C. Grounding Busbars

1. Install grounding busbars as indicated on drawings. Install busbars horizontally, on insulated spacers 2 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.

D. Connections

1. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.
2. Stacking of conductors under a single bolt is not permitted when connecting to busbars.
3. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
 - a. Use crimping tool and the die specific to the connector.
 - b. Pretwist the conductor.
 - c. Apply an antioxidant compound to all bolted and compression connections.
4. Primary Protector: Bond to the TMGB with insulated bonding conductor.
5. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot of conductor length, up to a maximum size of 750 kcmil unless otherwise indicated.
6. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install vertically mounted horizontally mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB with No. 2 AWG bonding conductors.
7. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.
8. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.
9. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with ANSI/TIA-568.1-D and ANSI/TIA-568-C.2 when grounding shielded balanced twisted-pair cables.
10. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.
11. Access Floors: Bond all metal parts of access floors to the TGB.
12. Equipment Room Signal Reference Grid: Provide a low-impedance path between telecommunications cabinets, equipment racks, and the reference grid, using No. 6 AWG bonding conductors.
13. Install the conductors in grid pattern on 4-foot centers, allowing bonding of one pedestal from each access floor tile.
14. Bond the TGB of the equipment room to the reference grid at two or more locations.
15. Bond all conduits and raceways entering the equipment room to the TGB at the perimeter of the room

END OF SECTION 270050

COVER SHEET FOR
SUBMITTALS TO NEWCOMB & BOYD

Project: _____ Date: _____

Item: _____ Submittal Number: _____

Manufacturer: _____ Model: _____

Specification Paragraph and/or Drawing Number: _____

Options Included (if any): _____

Deviations (if any; if none, state so): _____

General Contractor Approval: _____

SECTION 270051 COMMUNICATIONS EQUIPMENT CABINETS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section includes responsibilities and obligations in support of the performance verification specified in Section 270090, Communications Performance Verification.
- B. The communications systems contractor shall be responsible for interfacing power and grounding provisions with work provided under these Sections.
- C. Refer to the General and Supplementary Conditions and Division 01 for special requirements and conditions which apply to all Sections of Division 27.

1.2 SUMMARY

- A. Provide design and engineering, labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation as required for the complete performance of the work, and as herein specified.
- B. The work specified includes, but shall not be limited to, requirements for cabinets, in data centers, computer rooms, and communications equipment rooms.
- C. Included in this section are the minimum composition requirements and installation methods for NetShelter SX Cabinets.
- D. Communications Equipment Cabinets in this section are part of an overall Server Room solution. Refer to T-Series drawing sheets, and Mechanical & Electrical drawings and specification sections related to this solution.

1.3 QUALITY ASSURANCE

- A. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner or Owner Representative. Equipment and materials shall be of the quality and manufacture indicated. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- B. Strictly adhere to all Building Industry Consulting Service International (BICSI), Electronic Industries Alliance (EIA) and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data cabling.
- C. Material and work specified herein shall comply with the applicable requirements of the standards and regulations as listed in Section 270010 – Communications General.

1.4 SUBMITTALS

- A. Provide product data for the following:
 - 1. Manufacturer's data sheets/cut sheets, specifications and installation instructions for all products (submit with bid).

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and lot number, if any.
 - 1. The unit shall be shipped fully assembled as one orderable SKU.
 - 2. The unit shall ship on a wooden pallet. Optional packaging shall be available for shipping cabinets with 1250 lbs to 2000 lbs of installed equipment.
 - 3. The unit shall be bolted to the wooden pallet for stability during shipment.
 - 4. The unit shall be protected by corrugated corners, which are stretch-wrapped to limit damage during handling.
- B. The unit shall have unpacking instructions including manufacturer's contact information for customer support. The customer shall store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
 - 1. The manufacturer shall offer an inside-delivery shipping option which includes reasonable delivery to the inside of a customer's building and removal and disposal of shipping material and packaging
 - 2. The 42U unit shall roll through a standard 2 meter or seven (7) foot office doorway.

1.2 PROJECT CONDITIONS

- A. Environmental Requirements: Do not install equipment until space is enclosed and weatherproof, wet work in space is completed and nominally dry, work above ceilings is complete, and ambient temperature and humidity conditions are and will be continuously maintained at values near those indicated for final occupancy.

1.3 WARRANTY

- A. The manufacturer shall warrant the unit to be free from defects in materials and workmanship for a minimum period of five years (two years in Japan) from the date of purchase. The manufacturer's obligation under this warranty shall be to repair or replace the unit, at its own sole option. This warranty shall not apply to equipment that has been damaged by accident, negligence, or misapplication or has been altered or modified in any way.
- B. The manufacturer shall warrant all accessories and options to be free from defects in materials and workmanship for a minimum period of two years from the date of purchase. The manufacturer's obligation under this warranty shall be to repair or replace the equipment, at its own sole option. This warranty shall not apply to equipment that has been damaged by accident, negligence, or misapplication or has been altered or modified in any way.

PART 2 - PRODUCT

2.1 MANUFACTURER

- A. Product specified is "NetShelter SX" Cabinet as manufactured by Schneider Electric. Items specified are to establish a standard of quality for design, function, materials, and appearance.

2.2 DESIGN REQUIREMENTS

- A. Equipment cabinets to store computer, data storage and networking equipment in the data centers, computer rooms and equipment rooms. Each cabinet shall be designed to provide a secure, managed environment for server and networking equipment. Cabinets shall be designed to accommodate power and cable management accessories that keep network and power cables separate and organized.

B. Physical Specifications:

1. Cabinet dimensions, equipment mounting compatibility and weight load ratings:

Internal Height	EIA-310	External Height	External Width	External Depth	Static Rating	Dynamic Rating
42U	19"	1991mm (78.40")	600mm (23.62")	1070mm (42.13")	1363 kg (3000lbs)	1022 kg (2250lbs)
42U	19"	1991mm (78.40")	750mm (29.53")	1070mm (42.13")	1363 kg (3000lbs)	1022 kg (2250lbs)
42U	19"	1991mm (78.40")	600mm (23.62")	1200mm (47.24")	1363 kg (3000lbs)	1022 kg (2250lbs)
42U	19"	1991mm (78.40")	750mm (29.53")	1200mm (47.24")	1363 kg (3000lbs)	1022 kg (2250lbs)
45U	19"	2124mm (83.62")	600mm (23.62")	1070mm (42.13")	1363 kg (3000lbs)	1022 kg (2250lbs)
45U	19"	2124mm (83.62")	750mm (29.53")	1070mm (42.13")	1363 kg (3000lbs)	1022 kg (2250lbs)
45U	19"	2124mm (83.62")	600mm (23.62")	1200mm (47.24")	1363 kg (3000lbs)	1022 kg (2250lbs)
45U	19"	2124mm (83.62")	750mm (29.53")	1200mm (47.24")	1363 kg (3000lbs)	1022 kg (2250lbs)
48U	19"	2258mm (88.90")	600mm (23.62")	1070mm (42.13")	1363 kg (3000lbs)	1022 kg (2250lbs)
48U	19"	2258mm (88.90")	750mm (29.53")	1070mm (42.13")	1363 kg (3000lbs)	1022 kg (2250lbs)
48U	19"	2258mm (88.90")	600mm (23.62")	1200mm (47.24")	1363 kg (3000lbs)	1022 kg (2250lbs)
48U	19"	2258mm (88.90")	750mm (29.53")	1200mm (47.24")	1363 kg (3000lbs)	1022 kg (2250lbs)
24U	19"	1198mm	600mm	1070mm	1363 kg	1022 kg

		(47.19")	(23.62")	(42.13")	(3000lbs)	(2250)lbs

2. The 42U unit shall have exterior maximum height to allow passage through a standard 2 Meter or 7 Ft. (84 in) doorway without tipping.
3. The 42U, 45U, and 48U units shall support a static load (weight supported by the casters and leveling feet) of at least 1,364 kg. (3,000 lb) total installed equipment weight.
4. The 42U, 45U, and 48U units shall support a rolling load (rolling on the casters) of at least 1,023 kg. (2,250 lb) total installed equipment weight.
5. The units (42U, 45U, 48U) shall ship with a perforated front door, perforated split rear doors, four (4) half-height side panels, toolless roof, two (2) vertical frame posts, four (4) adjustable vertical mounting rails, minimum of two (2) and maximum of four (4) vertical PDU mount cable organizers, four (4) leveling feet and four (4) casters, baying and grounding hardware pre-installed by the manufacturer.

C. Material Requirements

1. All weight bearing components shall be constructed from steel with a thickness no less than 0.9mm (20 gauge).
2. All sheet metal parts shall be painted using a powder coat paint process.
3. Plastic materials shall comply with Underwriters Laboratory Specification 94 with HB rating (UL94 V-1) or better.
4. All interior components of the cabinets shall not have electroplated zinc coating to minimize zinc whiskers near active equipment.

D. Access and Installation:

1. The unit shall provide 42U, 45U, or 48U of equipment vertical mounting space.
2. The vertical mounting rails shall be easily adjustable to allow different mounting depths.
 - a. Each vertical mounting rail shall be marked on both sides with lines showing the top and bottom of each U and the number U space next to the middle hole. Each U consists of three square holes and is 1.75 inches (44.45 mm) high.
3. The unit shall include M6 caged nuts, bolts and cup washers, and caged nut tool for the mounting of equipment inside the unit.
4. Both the front and rear doors shall be designed with lift-off hinges allowing for quick and easy detachment without the use of tools.
 - a. The front and rear doors shall open a minimum of 120 degrees to allow easy access to the interior.
 - b. The front door of the unit shall be reversible so that it can be mounted on either side.
 - c. Split rear doors are provided for increased service clearance.
 - d. The front door of the unit shall be capable of being installed on the rear of the unit and the rear doors shall be capable of being installed on the front of the unit.
5. The unit shall include half-height side panels that are removed without tools using easy finger latches for fast access to cabling and equipment.
 - a. The side panels on the unit shall double as privacy panels when the units are bayed together.
 - b. Side panels shall be flush with the frame so the overall width of the unit does not change with the side panels installed.
 - c. Baying brackets must provide two sets of mounting holes for standard cabinet spacing of 24" or 600mm.
6. Grounding:
 - a. All cabinet components such as doors, side panels, roofs, etc. shall be bonded directly to the frame.

- b. Grounding points shall be provided on the cabinet's frame to externally bond each unit to the building ground.

2.3 VENTILATION

- A. The unit shall have ventilated front and rear doors to provide adequate airflow required by the major server manufacturers.
- B. The unit shall have a minimum total ventilation area for the front door, split rear doors, and roof as specified in the table below:

Internal Height	External Width	External Depth	Perforated Front Door	Perforated Rear Doors
42U	600mm (23.62")	1070mm (42.13")	5930 cm ² (919 in ²)	6689 cm ² (1036 in ²)
42U	750mm (29.53")	1070mm (42.13")	7889 cm ² (1222 in ²)	8669 cm ² (1343 in ²)
45U	600mm (23.62")	1070mm (42.13")	6348 cm ² (984 in ²)	7154 cm ² (1109 in ²)
45U	750mm (29.53")	1070mm (42.13")	8470 cm ² (1313 in ²)	9290 cm ² (1440 in ²)
48U	600mm (23.62")	1070mm (42.13")	6758 cm ² (1047 in ²)	7626 cm ² (1182 in ²)
48U	750mm (29.53")	1070mm (42.13")	9004 cm ² (1395 in ²)	9892 cm ² (1533 in ²)
24U	600mm (23.62")	1070mm (42.13")	3458 cm ² (536 in ²)	3759 cm ² (583 in ²)

- C. The unit shall provide the means to mount optional cooling accessories for high-density applications.
- D. The manufacturer shall offer an optional toolless blanking panel kit to prevent the recirculation of hot exhaust air.

2.4 CABLE ACCESS

- A. Top cable management openings provided in the cabinet roof.

Internal Height	External Width	External Depth	Openings Located on Roof	Opening with Roof Removed
42U/ 45U/ 48U	600mm (23.62")	1070mm (42.13")	Two 75mm (2.96") x 644mm (1.64"), One 240mm (9.45") x 92mm (3.61"), and Five 171mm (6.75") x 54mm (2.14") Rectangular Openings	567mm (22.31") x 892mm(35.10")
42U/ 45U/ 48U	750mm (29.53")	1070mm (42.13")	Two 75mm (2.96") x 644mm (1.64"), One 240mm (9.45") x 92mm (3.62"), and Five 171mm (6.75") x 54mm (2.14") Rectangular Openings	717mm (28.20") x 892mm (35.10")
42U/ 45U/ 48U	600mm (23.62")	1200mm (47.24")	Two 66mm (2.60") x 904mm (35.60") and nine 171mm (6.75") x 54mm (2.14") Rectangular Openings	567mm (22.32") x 1023mm (40.28")
42U/ 45U/ 48U	750mm (29.53")	1200mm (47.24")	Two 66mm (2.60") x 904mm (35.60") and nine 171mm (6.75") x 54mm (2.14") Rectangular Openings	716mm (28.20") x 1023mm (40.28")
24U	600mm (23.62")	1070mm (42.13")	Three 60mm (2.36") Diameter Circular Openings	567mm (22.31") x 892mm (35.10")

- B. Cable opening edges shall be protected with plastic grommets or radiused edges.
- C. Bottom cable management opening provided in the cabinet base:

Internal Height	External Width	External Depth	Main Base Opening
24U/42U/45U/48U	600mm (23.62")	1070mm (42.13")	567mm (22.31") x 831mm (32.71")
42U/45U/48U	750mm (29.53")	1070mm (42.13")	717mm (28.25") x 832mm (32.74")
42U/45U/48U	600mm (23.62")	1200mm (47.24")	567mm (22.32") x 962mm (37.87")
42U/45U/48U	750mm (29.53")	1200mm (47.24")	717mm (28.23") x 962mm (37.87")

- D. Side cable management opening shall be provided in the cabinet base. A minimum of two and maximum of four vertical PDU mount cable organizers shall be offered.

2.5 ENVIRONMENTAL

- A. The unit shall have a minimum of IP 20 rating for protection against touch, ingress of foreign bodies, and ingress of water.
- B. Manufacturer must certify products are RoHS and China RoHS compliant.
- C. The cabinet shall both protect the user from mechanical hazards and generally meet the requirements (stability, mechanical strength, aperture sizes, etc.) as defined in IEC 60950 Third Edition.

2.6 SECURITY

- A. The unit shall include a front door lock, rear door lock and four (4) side panel locks. All six (6) locks shall be configured to use the same key. Two copies of the key shall be included.
 - 1. Replacement key lock cylinders from the handle manufacturer shall be available to provide a minimum of 220 unique key combinations on the front and rear doors.
- B. The manufacturer shall provide optional products and accessories to allow the cabinet environment to be monitored for temperature, humidity, and electronic pass key door access.
- C. The unit shall have mounting provisions for optional door alarm switches to monitor access to the cabinet doors.

2.7 STABILIZATION

- A. The unit shall ship with provisions for stabilization in the field using the pallet mounting brackets.
- B. The manufacturer shall offer an optional stabilizer kit that can be attached to the cabinet frame. The frame can then be bolted to the floor.
- C. The manufacturer shall offer an optional bolt down kits, consisting of brackets and mounting hardware that attach to the cabinet frame and which must be anchored to the sub-floor for compliance with the local Uniform Building Code (UBC).
- D. The manufacturer shall supply structural calculations by a professionally registered engineer showing compliance with the local UBC for floor anchoring.
- E. The unit shall have four (4) adjustable leveling feet to help provide a stable base in the event of an uneven floor surface and to prevent rolling.

2.8 OPTIONAL ACCESSORIES

- A. The manufacturer shall offer the following optional accessories as required to accommodate customer requirements.
 - 1. RM LCD Monitor/Keyboard drawer: The manufacturer shall offer a 1U high, rack-mounted LCD monitor/keyboard drawer to maximize space in a data center environment.
 - 2. Cooling: The manufacturer shall offer roof-mounted fan trays, door mounted fan trays, monitoring devices, and stand alone cooling units for maintaining a cool environment.
 - 3. Rack Power Distribution Units: The manufacturer shall offer a variety of single-phase and three-phase rack mount power distribution units with current monitoring outlet switching, and remote management capabilities.

4. Cable Management: The manufacturer shall offer a variety of cable management accessories to neatly organize the routing of data and power cables within the cabinet.
5. Shelving: The manufacturer shall offer as optional accessories various fixed and sliding shelves with the ability to support up to 250 lbs of non-rack mount equipment.
6. Uninterruptible Power Supplies: The manufacturer shall offer various rack mounted uninterruptible power supplies (UPS), with user-replaceable and hot-swappable batteries, and with extended runtime options available

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Architect/Engineer, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected. Beginning the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.2 INSTALLATION

- A. NetShelter SX Equipment Cabinets
- B. Provide all components of the cabinet system (including any optional accessories).
- C. Install and adjust to position all cabinet components including accessories. Install vertical cable managers, power distribution and equipment-mounting rails, using the manufacturer's installation instructions prior to baying and/or placing the cabinet for attachment to the building and before installing any rack-mount equipment into the cabinet. Shelves, horizontal cable managers and filler panels, if used, may be installed after the cabinet is placed.
- D. When attached to the structural floor, the installer shall provide installation hardware.
- E. When used in a multi-cabinet bay, cabinets shall be attached side-by-side using included baying kits according to the manufacturer's instructions.
- F. Attach overhead ladder rack or cable tray to the ceiling or the top of the cabinet. The ladder rack/cable tray shall be positioned so that it does not interfere with the hot air exhaust through the cabinet's top panel.

Note: Seismic installations require additional bracing of cabinets and overhead cable runways to the building structure as advised by and certified by a licensed structural engineer.

- G. Cabinets shall be securely bonded to a common ground. Attach a bonding conductor sized as defined in J-STD-607-A and as defined by local code or the authority having jurisdiction (AHJ) between the common ground and the cabinet. Attach the bonding conductor to the cabinet using a ground terminal block according to the manufacturer's installation instructions. The installer shall provide the bonding conductor and other necessary hardware required to make the connections between the cabinet and the common ground.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer Field Service

1. Replacement parts: Parts shall be available through the worldwide service organization 24 hours a day, 7 days a week, and 365 days a year.

END OF SECTION 270051

SECTION 270090 - COMMUNICATIONS PERFORMANCE VERIFICATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Performance verification is an ongoing process and shall be performed throughout construction. Performance verification confirms that systems are operating in a manner consistent with the Construction Documents.
- B. This Section covers communications systems performance verification, as required to demonstrate that the equipment and systems of Section 271000, Structured Cabling Systems and Section 271100, Broadband Cabling Systems are ready for safe and satisfactory operation, as defined by the Construction Documents. Performance verification shall include, but shall not be limited to, identification communications devices, cabling and equipment, cleaning, check-out, testing and adjusting of systems, preparation of equipment and systems documentation and of maintenance and operation manuals, Owner training, and preparation of record drawings.
- C. Performance verification shall conclude with the completion of required testing, training, and system documentation as specified herein and required to demonstrate the proper operation of the communications equipment and systems.

1.2 QUALITY ASSURANCE

- A. Provide a Communications Systems Performance Verification Supervisor to oversee the performance verification process for the communications systems. The Communications Systems Performance Verification Supervisor shall have 10 years experience in communications systems contracting. The Communications Systems Performance Verification Supervisor shall become familiar with the Owner's project requirements and the requirements of the performance verification process as defined in this Section. The Communications Systems Performance Verification Supervisor shall coordinate and execute the required performance verification activities.
- B. The Communications Systems Performance Verification Supervisor shall review submittal data for conformance with the requirements of the Project, shall monitor compliance with the requirements specified herein for storage and protection of equipment during construction, shall oversee testing, and shall document that the scheduled and specified performance requirements of each system have been accomplished.
- C. Refer to ASHRAE Guideline 0.2-2015, The Commissioning Process for Existing Systems and Assemblies, and ASHRAE Guideline 4-2019 Preparation of Operating and Maintenance Documentation for Building Systems.

1.3 PERFORMANCE VERIFICATION

- A. The Communications Systems Performance Verification Supervisor shall be responsible for scheduling, supervising, coordinating, and executing the testing and performance verification activities as specified herein.
- B. Performance verification requirements for each phase are as follows:
 - 1. Construction Phase:
 - a. During the construction phase of the Project, transmit a status update report upon request to the Engineer (via e-mail), using the form included herein. (The Engineer will e-mail an electronic version of the attached form to the Contractor upon request.) The status update

report shall include digital photographs of areas where significant progress has been made. Digital photographs shall be minimum 1200 x 1600 pixels in resolution. Both the detail in the report and the detail in the photographs shall be sufficient for the Engineer to assess the progress made to date. Periods of inactivity will require only a retransmission of the most recent form (via e-mail), updated to reflect the new date, and that "no significant progress has been made since the last status report was submitted". Status reports will not be requested more than once every 2 weeks.

- b. Provide documentation of installed systems and equipment and develop functional testing procedures, prior to normal operation and maintenance manual submittals. This documentation shall include detailed manufacturer installation, operating, troubleshooting and maintenance procedures; full factory testing reports, if any; and full warranty information, including responsibilities of the Owner to keep the warranty in force. In addition, the installation, the check-out materials that are actually shipped inside the equipment, and the actual field check-out sheet forms to be used by the factory or field technicians shall be submitted to the Architect.
 - c. Develop and submit to the Architect for review and comment, prior to system functional testing, a complete functional testing plan and functional testing checklists for equipment and communications systems to be verified.
 - d. Assist in clarifying the proposed operation and control of communications systems equipment in areas where the specifications, drawings, or equipment documentation is not sufficient for writing detailed testing procedures.
 - e. Review the proposed functional test procedures to ensure feasibility, safety, and equipment protection. Obtain approval from the Architect for proposed functional test procedures.
 - f. Prepare a preliminary schedule for performance verification activities, including equipment testing and adjusting from start to completion, and update the schedule during the construction period, as appropriate. Notify the Architect immediately when performance verification activities not yet performed, or not yet scheduled, will delay construction.
 - g. Provide functional testing for equipment and execute the communications systems related portions of the functional checklists for verified equipment during the testing process.
 - h. Perform and document functional tests results, providing a copy to the Architect.
2. Acceptance Phase:
 - a. Correct deficiencies (differences between specified and tested performance) as identified and interpreted by the Engineer and retest the equipment, as required to demonstrate proper operation and performance.
 - b. Prepare operation and maintenance manuals as specified.
 - c. Maintain marked-up record drawings and produce final record drawings of project drawings and contractor-generated coordination drawings.
 - d. Provide specified training of the Owner's operating personnel.
 - e. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
 3. Warranty Period: Correct deficiencies and make necessary adjustments to operation and maintenance manuals, and as-built drawings system or equipment modifications made during the warranty period.

- C. The Communications Systems Performance Verification Supervisor shall schedule, coordinate, assemble and deliver the documentation of the training required by these Communications Specifications.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Standard testing equipment needed to perform the required testing shall be provided by the Contractor for the equipment or system being tested.

- B. Test equipment shall be of the quality and accuracy required to test and/or measure system performance with the tolerances specified and shall have been calibrated by the manufacturer within the last 12 months, or as specified herein. Equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates available on request.
- C. Test equipment and modules shall be within the calibration period recommended by the manufacturer of the test equipment in order to achieve the manufacturer-specified measurement accuracy, and shall be within 1 year of the test date.
- D. Testing shall be accomplished using Fluke Networks, Ideal Industries, or Viavi test instruments capable of supporting the functional frequency range of the cable type being tested.
- E. The test equipment shall support the following requirements:
 - 1. Level III accuracy as defined in TIA/EIA 568.1E-2015 Addendum 2020 and TIA 1152-A-2016.
 - 2. Digital with fault location capabilities.
 - 3. Measure ELFEXT and Power Sum ELFEXT.
 - 4. Distinguish external noise from NEXT.

PART 3 - EXECUTION

3.1 CLEANING

- A. Equipment and Equipment Rooms:
 - 1. Remove dust, dirt, rust, stains, and temporary covers.
 - 2. Foreign matter shall be blown, vacuumed, or cleaned out of and from equipment, and enclosures.
 - 3. Clean and polish identification plates.
 - 4. In equipment rooms, clean equipment, conduit, and room surfaces from dust and dirt and maintain in a clean condition from date of substantial completion until final completion of work and corrective work.

3.2 SUBMITTALS

- A. Submit additional documentation as required to support the performance verification process. This additional submittal documentation shall include, at a minimum, the proposed functional testing plan, and functional testing checklists. Refer to Section 271000 for additional submittal requirements.

3.3 FUNCTIONAL TESTING

- A. General:
 - 1. Functional testing shall be performed as required to ensure that the equipment and systems are properly installed and ready for operation, so that acceptance testing may proceed without delays. Follow the approved functional testing procedures. Sampling strategies shall not be used for functional testing. The functional testing for equipment and subsystems of a given system shall be successfully completed and documented prior to acceptance testing of the system.
 - 2. Functional testing shall be done by trained technicians who have successfully attended an appropriate manufacturer training program and have obtained a certificate as proof thereof. The training program certificate shall be submitted with the test equipment calibration certificate before beginning the functional testing.
 - 3. Detailed functional testing plans shall be developed for communications equipment and systems that are to be verified as specified herein. The proposed procedures and functional testing

- documentation shall be reviewed to ensure that there is written documentation that each of the manufacturer-recommended procedures has been completed.
4. The functional testing plan shall include
 - a. Fiber optic link loss budget calculations.
 - b. Set up procedures for test equipment.
 - c. Reference cord/launch cable configuration.
 - d. Estimated schedule for testing cables.
 - e. Failure resolution process.
 5. The functional testing plan shall include checklists and procedures with specific boxes or lines for recording and documenting each step of the plan. Each checklist shall include a summary statement with a signature block at the end of the plan.
- B. Structured Cabling System Functional Tests:
1. General:
 - a. Applies to Section 271000, Structured Cabling Systems and Section 271100, Broadband Cabling Systems.
 - b. Test 100% of the cabling links.
 - c. Input the test results into the test instrument manufacturer's reporting software. Tabulate and analyze results to ensure cabling system meets requirements specified herein.
 - d. Document failed pairs or strands. Repair or replace cable, then retest. Repeat procedure until cable passes requirements.
 - e. Upon completion provide a hard copy report in 3-ring binder and in digital format for review and approval.
 - f. A representative of the Owner shall be invited to witness the field testing. The representative shall be notified of the start date of the testing phase at least 5 business days before testing commences.
 2. Communications Cable Horizontal Testing:
 - a. Each outlet/cable shall be tested and certified in accordance with TIA/EIA 568.1E-2015 Addendum 2020. Each pair shall be tested. A test cable shall be used at the test unit end. The test cable shall meet the requirements of the structured cabling system's channel warranty. Testing shall occur in both directions.
 - b. Category 6 permanent links shall pass the following basic tests:
 - 1) Each cabling link shall be tested in accordance with the field test specifications defined in TIA/EIA 568.1E-2015 Addendum 2020.
 - 2) Wire map shall report pass if the wiring of each wire-pair is determined to be correct as defined in TIA/EIA 568.1E-2015 Addendum 2020.
 - 3) Length test result shall report measured length of each pair of a basic link and channel based on the propagation delay measurement and the average value for nominal velocity of propagation. The physical length of the link shall be calculated using the pair with the shortest electrical delay. This length figure shall be reported and shall be used for making the pass/fail decision. The pass/fail criteria are based on the maximum length allowed for the basic link configuration plus 10% to allow for the variation and uncertainty of the nominal velocity of propagation.
 - 4) Near end crosstalk loss shall be tested for each wire pair combination from each end of the link (a total of 12 pair combinations). This parameter shall be measured from 1 MHz through 250 MHz with a maximum step size of 0.50 MHz. For a pass condition, the worst case NEXT margin and the worst value of NEXT shall be recorded for each case, the frequency at which it occurs, and the test limit value at this frequency.
 - 5) Power sum near end crosstalk loss shall be evaluated and reported for each wire pair from both ends of the link under test (a total of 8 results). Evaluate this parameter from 1 MHz through 250 MHz with a maximum step size of 0.50 MHz. For a pass

- condition, the worst case PSNEXT margin and the worst PSNEXT value shall be recorded, the frequency at which it occurs, and the test limit value at this frequency.
- 6) Equal level far end crosstalk pair-to-pair loss shall be measured for each wire pair combination from both ends of the link under test. ELFEXT shall be measured from 1 MHz through 250 MHz with a maximum step size of 0.50 MHz. For a pass condition, the worst case ELFEXT margin and the worst ELFEXT value shall be recorded, the frequency at which it occurs, and the test limit value at this frequency.
 - 7) Power sum equal level far end crosstalk loss shall be calculated by combining the effects of the FEXT disturbance from 3 wire pairs on the fourth one. The test shall yield 8 wire pair combinations. Each wire pair shall be evaluated from 1 MHz through 250 MHz with a maximum step size of 0.50 MHz. For a pass condition, the worst case PSELFEXT margin and the worst PSELFEXT value shall be recorded, the frequency at which it occurs, and the test limit value at this frequency.
 - 8) Return loss shall be measured from both ends of the link under test from 1 MHz through 250 MHz with a maximum step size of 0.50 MHz. For a pass condition, the worst case RL margin and the worst RL value shall be recorded, the frequency at which it occurs, and the test limit value at this frequency.
 - 9) Attenuation-to-crosstalk ratio shall be calculated to determine the bandwidth for a two wire pair network in terms of signal-to-noise ratio. This calculation yields 12 combinations (6 from each end of the link). For a pass condition, the worst case ACR margin and the worst ACR value shall be recorded, the frequency at which it occurs, and the test limit value at this frequency.
 - 10) For Category 6 STP cabling, the shield continuity shall be measured between both permanent link end-point terminations.
 - a) Ground cabling shield on both ends with the measured impedance between the cable shield and the nearest receptacle ground not exceeding 5 ohms.
- c. Category 6A permanent links shall pass the following basic tests:
- 1) Every cabling link in the installation shall be tested for in accordance with the field test specifications in TIA/EIA 568.1E-2015 Addendum 2020.
 - 2) Wire Map: the test equipment shall report Pass if the wiring of each wire-pair from end to end is determined to be correct. The Wire Map results shall include the continuity of the shield connection if present.
 - 3) Length: the test equipment shall be capable of measuring length of all pairs of a basic link or channel based on the propagation delay measurement and the average value for NVP (1). The physical length of the link shall be calculated using the pair with the shortest electrical delay. This length figure shall be reported and shall be used for making the Pass/Fail decision. The Pass/Fail criteria are based on the maximum length allowed for the Permanent Link configuration 295' plus 10% to allow for the variation and uncertainty of NVP.
 - 4) Insertion Loss (Attenuation): Insertion Loss is a measure of signal loss in the permanent link or channel. The term Attenuation has been used to designate Insertion Loss. Insertion Loss shall be tested from 1 MHz through 500 MHz in maximum step size of 1 MHz. It is preferred to measure insertion loss at the same frequency intervals as NEXT Loss in order to provide a more accurate calculation of the Attenuation-to-Crosstalk ratio (ACR) parameter. Minimum test results documentation (summary results): identify the worst wire pair (1 of 4 possible). The test results for the worst wire pair shall show the highest attenuation value measured (worst case), the frequency at which this worst case value occurs, and the test limit value at this frequency.
 - 5) NEXT Loss: pair-to-pair near-end crosstalk loss (abbreviated as NEXT Loss) shall be tested for each wire pair combination from each end of the link (a total of 12 pair combinations). This parameter shall be measured from 1 through 500 MHz. NEXT Loss measures the crosstalk disturbance on a wire pair at the end from which the disturbance signal is transmitted (near-end) on the disturbing pair. The maximum step

size for NEXT Loss measurements shall not exceed the maximum step size defined in the standard as shown in Table 1. Minimum test results documentation (summary results): identify the wire pair combination that exhibits the worst case NEXT margin (2) **and** the wire pair combination that exhibits the worst value of NEXT (worst case). NEXT shall be measured from each end of the link-under-test. These wire pair combinations shall be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

Table 1 -- Maximum frequency step size as defined in TIA 1152-A-2016.

Frequency Range (MHz)	Maximum Step size (MHz)
1 - 31.25	0.15
31.26 - 100	0.25
100 - 250	0.50
250 - 500	1.00

- 6) PS NEXT Loss: Power Sum NEXT Loss shall be evaluated and reported for each wire pair from both ends of the link under-test (a total of eight results). PS NEXT Loss captures the combined near-end crosstalk effect (statistical) on a wire pair when all other pairs actively transmit signals. Like NEXT this test parameter shall be evaluated from 1 through 500 MHz and the step size shall not exceed the maximum step size defined in the standard as shown in Table 1. Minimum test results documentation (summary results): identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for PS NEXT. These wire pairs shall be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.
- 7) ACR-F, pair-to-pair: Attenuation Crosstalk Ratio Far-end is calculated from the pair-to-pair FEXT Loss. It shall be measured for each wire-pair combination from both ends of the link under-test. FEXT Loss measures the crosstalk disturbance on a wire pair at the opposite end (far-end) from which the transmitter emits the disturbing signal on the disturbing pair. FEXT is measured to compute ACR-F Loss that shall be evaluated and reported in the test results. ACR-F measures the relative strength of the far-end crosstalk disturbance relative to the attenuated signal that arrives at the end of the link. This test yields 24 wire pair combinations. ACR-F shall be measured from 1 through 500 MHz and the maximum step size for FEXT Loss measurements shall not exceed the maximum step size defined in the standard as in Table 1. Minimum test results documentation (summary results): identify the wire pair combination that exhibits the worst-case margin and the wire pair combination that exhibits the worst value for ACR-F. These wire pairs shall be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.
- 8) PS ACR-F Loss: Power Sum Attenuation Crosstalk Ratio Far-end is a calculated parameter that combines the effect of the FEXT disturbance from three wire pairs on the fourth one. This test yields eight wire-pair combinations. Each wire-pair is evaluated from 1 through 500 MHz in frequency increments that do not exceed the maximum step size defined in the standard as shown in Table 1. Minimum test results documentation (summary results): the wire pair that exhibits the worst pair combinations shall be identified for the tests performed from each end. Each reported

case shall include the frequency at which it occurs as well as the test limit value at this frequency.

- 9) Return Loss: Return Loss (RL) measures the total energy reflected on each wire pair. Return Loss shall be measured from both ends of the link-under-test for each wire pair. This parameter shall also be measured from 1 through 500 MHz in frequency increments that do not exceed the maximum step size defined in the standard as shown in Table 1. Minimum test results documentation (summary results): identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for Return Loss. These wire pairs shall be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.
- 10) Propagation Delay: Propagation Delay is the time required for the signal to travel from one of the link to the other. This measurement shall be performed for each of the four wire pairs. Minimum test results documentation (summary results): identify the wire pair with the worst-case propagation delay. The report shall include the propagation delay value measured as well as the test limit value.
- 11) Delay Skew: this parameter shows the difference in propagation delay between the four wire pairs. The pair with the shortest propagation delay is the reference pair with a delay skew value of zero. Minimum test results documentation (summary results): identify the wire pair with the worst-case propagation delay (the longest propagation delay). The report shall include the delay skew value measured as well as the test limit value.
- 12) PS ANEXT: pair-to-pair Alien NEXT (ANEXT) contributions is measured by applying the stimulus signal at the near end to one wire pair of a disturbing link and measuring the coupled signal at the near end of a wire pair in a disturbed link. This process is repeated for every wire pair in a disturbing link. The PS ANEXT for each wire pair in a disturbed link is obtained by the power sum addition of all the pair-to-pair ANEXT results to that wire pair from all wire pairs in disturbing links. All the links that are bundles with the disturbed link shall be included as disturbing links. In addition, links that are terminated in adjacent positions in a patch panel or interconnect panel shall also be included as disturbing links in this test.
 - a) Minimum test results documentation (summary results): identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for PS ANEXT. These wire pairs shall be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs as well as the test limit value at this frequency.

3. Other Copper Cabling Testing:

- a. Each pair of other copper cabling shall be tested.
- b. Testing shall include:
 - 1) Cable length.
 - 2) Continuity.
 - 3) Proper connectivity.
 - 4) Open pairs.
 - 5) Short circuits.
 - 6) Reversed pairs.
 - 7) EMI noise induction.
 - 8) Attenuation.
 - 9) Near end cross talk.

4. Optical Fiber Testing:

- a. Each fiber optic cabling link in the installation shall be tested in accordance with TIA/EIA 568.1E-2015 Addendum 2020.
- b. Each fiber optic cabling link shall be tested bidirectionally.

- c. The test equipment for multimode fiber cabling shall meet the requirements of TIA 526-14-C-2015. Test equipment for single-mode fiber cabling shall meet the requirements of TIA 526-7A-2015.
 - d. A pass or fail condition shall not be valid if the test equipment has not been set-up and configured according to the manufacturer's instructions and requirements. The test equipment's reference values shall be within the manufacturer's recommended values.
 - e. Fiber optic launch cables, patch cables, and adapters shall be of high quality and shall not show excessive wear resulting from repetitive coiling and storing of the test equipment interface adapters. The fiber optic launch cables, patch cables, test cords, and adapters shall be of the same manufacturer as the test equipment or the manufacturer providing the channel warranty. The test cords for OLTS testing shall be between 36" and 180" in length. The test cords for OTDR testing shall be approximately 328' for the launch cable and at least 82' for the receive cable.
 - f. The pass or fail condition for the link-under-test shall be determined by the results of the required individual tests. A pass or fail result for each parameter shall be determined by comparing the measured values with the test limit specified herein for that parameter. Results indicated as marginal pass as defined by the test equipment manufacturer shall be deemed as failures.
5. Optical Loss Testing:
- a. The insertion loss shall be calculated by the following formulae defined in TIA/EIA 568.1E-2015 Addendum 2020 using the following values:
 - 1) Insertion loss = Cable attenuation + Connector attenuation + Splice attenuation.
 - 2) Cable attenuation (dB) = Attenuation coefficient (dB/km) x Length (km).
 - 3) Connector attenuation (dB) = Number of connector pairs x Connector loss (dB).
 - 4) Maximum allowable connector loss = 0.5 dB.
 - 5) Splice attenuation (dB) = Number of splices (S) x Splice loss (dB).
 - 6) Maximum allowable splice loss = 0.15 dB.
 - b. The above specified link test attenuation limits are based on the use of the One Reference Jumper Method described in TIA 526-14-C-2015, Method B and TIA 526-7A-2015.
 - c. Link attenuation shall not include any active devices or passive devices other than cable, connectors, and splices.
 - d. Cable test results with negative loss values shall be deemed invalid. Fiber terminations shall be cleaned, evaluated, and retested until the results contain no negative loss values at no additional cost to the Owner. Verify that the cable test results are valid.
 - e. Multimode horizontal links: acceptable insertion loss for a multimode horizontal fiber optic cabling system is based on the maximum 295' distance. Horizontal fiber optic cabling link segments shall be tested at 850 nm and 1300 nm in accordance with TIA 526-14-C-2015, Method B, One Reference Jumper. Horizontal links may be tested using a fixed upper limit for attenuation of 2.0 dB. This value includes the loss of two connector pairs, one pair at the communications outlet/connector and one pair at the horizontal cross-connect, plus 295' of fiber optic cable.
 - f. Multimode backbone links shall be tested bidirectionally at both 850 nm and 1300 nm in accordance with TIA 526-14-C-2015.
 - 1) Link attenuation shall be based upon the use of a light source categorized by an Encircled Flux (EF) per Annex E of TIA 526-14-C-2015 utilizing one reference jumper per Annex A.
 - 2) Links designed to be used with network applications that use laser light sources (underfilled launch conditions) shall be tested with test equipment based on laser light sources.
 - 3) For Gigabit Ethernet compliant certification (IEEE 802.3-2018/ AMD 2020 application), use test equipment which uses a vertical cavity surface emitting laser at 850 nm (compliant with 1000BASE-SX) and an FP laser at 1320 nm (compliant with 1000BASE-LX).

- g. Single-mode backbone links shall be tested bidirectionally at both 1310 nm and 1550 nm in accordance with TIA 526-7A-2015, Method A.1, One Reference Jumper. Single-mode links shall be certified with test tools using laser light sources at 1310 nm and 1550 nm.

C. Retesting of equipment and/or systems:

- 1. Provide labor and materials required for retesting of any functional test found to be deficient.
- 2. Prior to retesting, submit required data indicating that the deficient items have been completed and/or corrected to the Architect for approval and rescheduling of the functional test. If during the retesting it becomes apparent that the deficient items have not been completed and/or corrected as indicated in the data provided by the Contractor, the retesting shall be stopped. Costs for the Communications Systems Performance Verification Supervisor to further supervise the retesting of a functional test shall be the responsibility of the Contractor.

3.4 ACCEPTANCE TESTING

- A. A representative of the Owner may elect to test 5% of the installed cables. The test results will be compared with the submitted results. In the event that more than 2% of the compared results differ from the submitted results, the Owner may contract with a third-party testing firm to retest 100% of the installation and the cost shall be borne by the Contractor.

3.5 NONCONFORMANCE AND APPROVALS

- A. Provide the Architect with a list of outstanding items of the functional testing procedures that were not completed successfully within 2 days of test completion. The Engineer will then review the Contractor's functional testing reports and submit either a noncompliance report or an approval form to the Contractor. The Contractor shall work with the Engineer to retest deficiencies or uncompleted items. Correct items that are deficient or incomplete in the checklists and tests in a timely manner, and notify the Architect as soon as outstanding items have been corrected. Resubmit an updated report and a statement of correction on the original noncompliance report. When requirements are completed, the Engineer will recommend approval of the functional testing of each system.
- B. As testing progresses and deficiencies are identified, work with the Engineer to resolve the issues.

3.6 TESTING DOCUMENTATION

- A. The test results/measurements shall be submitted in both the test equipment manufacturer's raw data file and searchable PDF format files.
- B. The database for the complete project, including twisted-pair copper cabling links, if applicable, shall be stored and delivered in digital format prior to Owner acceptance of the building. This digital format shall include the software tools required to view, inspect, and print any selection of the test reports.
- C. The detailed test results documentation data shall be provided in an electronic database for each copper cabling link and shall contain the following information:
 - 1. The identification of the customer site as specified by the Owner.
 - 2. The identification of the cable link in accordance with the naming convention defined in the overall system documentation.
 - 3. The overall Pass/Fail evaluation of the link-under-test.
 - 4. The name of the test limit selected to execute the stored test results.
 - 5. The cable type and the value of NVP used for length calculations.
 - 6. The date and time the test results were saved in the memory of the test equipment.
 - 7. The brand name, model, serial number, and calibration date of the test equipment.

8. The identification of the test equipment interface.
 9. The revision of the test equipment software and the revision of the test limits database in the test equipment.
 10. The test results information must contain information on each of the required test parameter.
- D. The detailed test results documentation data is to be provided in an electronic database for each tested optical fiber and shall contain the following information.
1. The identification of the customer site as specified by the Owner.
 2. The name of the test limit selected to execute the stored test results.
 3. The name of the personnel performing the test.
 4. The date and time the test results were saved in the memory of the test equipment.
 5. The manufacturer, model, serial number, and calibration date of the test equipment.
 6. The version of the test software and the version of the test limit database held within the test instrument.
 7. The fiber identification number.
 8. The length for each optical fiber.
 9. Test results to include OLTS attenuation link and channel measurements at the appropriate wavelength and the margin (difference between the measured attenuation and the test limit value).
 10. The overall Pass/Fail evaluation of the link-under-test for OLTS measurements.
- E. The final test results file submitted shall be in order, organized, and complete.
- F. Record Copy and As-Built Drawings:
1. Provide record copy drawings at end of the project in digital format. Record copy drawings at the end of the project shall be in CAD format and include notations reflecting the as-built conditions of any additions to or variation from the drawings provided such as, but not limited to, cable paths and termination points. CAD drawings shall incorporate the same labeling terminology as the test results.
 2. The as-built drawings shall include, but not be limited to, block diagrams, frame and cable labeling, cable termination points, equipment room layouts and frame installation details. The as-builts shall include all field changes made up to construction completion, including:
 - a. Field directed changes to pull schedule.
 - b. Field directed changes to cross connect and patching schedule.
 - c. Horizontal cable routing changes.
 - d. Backbone cable routing or location changes.
 - e. Associated detail drawings.

3.7 OPERATION AND MAINTENANCE DOCUMENTATION PACKAGE

- A. The Communications Systems Performance Verification Supervisor shall compile and prepare documentation for equipment and systems covered in these Communications Specifications, and deliver this documentation for inclusion in the operation and maintenance manuals prior to the training of the Owner's personnel. The Architect shall receive a copy of the operation and maintenance manuals for review.

END OF SECTION 270090

PROJECT STATUS UPDATE TO NEWCOMB & BOYD	
Date: _____	
Covering progress for the dates of: _____ through: _____	
Project: _____	
Location: _____	
Expected date of completion: _____ Expected date of acceptance testing: _____	
General Contractor: _____ Subcontractor using this report: _____	
Contact: _____	Contact: _____
Telephone: _____	Telephone: _____
E-mail: _____	E-mail: _____
Summary of progress made since last report: _____	

Summary of progress to date: _____	

Outstanding RFIs: _____	

Outstanding change orders: _____	

Other issues or discrepancies: _____	

File Name of Photos sent via e-mail:	Areas covered/subject matter:
_____	_____
_____	_____
_____	_____

SECTION 271000 – STRUCTURED CABLING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section covers structured cabling systems.
- B. General provisions are specified in Section 270010, Communications General.
- C. Broadband cabling systems are specified in Section 271100, Broadband Cabling Systems.
- D. Pathways and Spaces are specified in Section 270050, Communications Pathways and Spaces
- E. This Section includes responsibilities and obligations in support of the performance verification specified in Section 270090, Communications Performance Verification.
- F. Copper Horizontal Cabling
 - 1. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.
 - 2. TIA-568.1-D requires that a minimum of two equipment outlets be installed for each work area.
 - 3. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
 - 4. Bridged taps and splices shall not be installed in the horizontal cabling.
 - 5. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.
- G. Copper and Optical Fiber Backbone Cabling
 - 1. Copper and Optical Fiber backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.
 - 2. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.
- H. Powered Fiber
 - 1. System must be a complete “rack to device” solution capable of powering and communicating with small cells, Wi-Fi hotspots, HD cameras, and variety of devices requiring optical communications and DC power in one system.
 - 2. The hybrid cable shall allow for “standalone” use for delivering of power and fiber communications for applications where both power and optical fiber communications.
- I. Patch Cords
 - 1. Refer to Part 3 of this Section for a list of all patch cord types, quantities, colors and lengths to be provided.

PART 2 - PRODUCTS

2.1 HORIZONTAL SUBSYSTEM:

A. Twisted Pair Cable

1. General

- a. Minimum compliant cables are not acceptable.
- b. Copper Clad Aluminum cables are not acceptable.
- c. Maximum pulling tension: 110 Newton's (25 pound-force)
- d. Operating temperature: -20 to 60 degrees C [-4 to 140 degrees F]

2. Cable Construction

- a. Listed CMP cable: Solid copper conductors with fluorinated ethylene propylene (FEP)/polyolefin insulation and an overall low smoke PVC jacket to achieve plenum rating by applicable NEC requirements.
- b. OSP outdoor cable rated for wet locations: Solid copper conductors with polyolefin insulation, polyolefin fluted center member with flooding compound, and black polyethylene jacket.

3. Category-6A

- a. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6A cable at frequencies up to 500MHz.
- b. Minimum Cable Performance Parameters:

<i>Electrical Parameter</i>	<i>Guaranteed Channel Margins to ANSI/TIA-568-C.2 (1 – 500MHz)</i>
Insertion Loss	3 %
NEXT	3.5 dB
PSNEXT	5 dB
PSACR-F	10 dB
Return Loss	3 dB
PSANEXT	2 dB
PSAACR-F	10 dB

- c. Conductors: 100-ohm, 23 AWG solid copper.
- d. Shielding/Screening: Unshielded twisted pairs (UTP)
- e. Jacket Color: As Indicated on Drawings
- f. Refer to Drawing Legend for locations to utilize Cat-6A Cable.
- g. Acceptable Cable Manufacturers:

- 1) Belden – 10GX
- 2) Berk-Tek – LANMark XTP
- 3) CommScope – Gigaspeed X10D
- 4) General Cable – GenSpeed 10
- 5) Hitachi – Supra 10G
- 6) Mohawk – GigaLAN 10
- 7) Superior Essex – 10Gain
- 8) Approved Equal

4. Category-6

- a. Description: Four-pair, balanced-twisted pair cable with internal spline certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.

b. Minimum Cable Performance Parameters

<i>Electrical Parameter</i>	<i>Guaranteed Channel Margins to ANSI/TIA-568-C.2 (1 – 250MHz)</i>
NEXT	5 dB
PSNEXT	5 dB
ACR	3 dB
PSACR	5 dB
ACR-F	5 dB
PSACR-F	5 dB

- c. Conductors: 100-ohm, 23 AWG solid copper.
- d. Shielding/Screening: Unshielded twisted pairs (UTP)
- e. Jacket Color: As Indicated on Drawings
- f. Refer to Drawing Legend for locations to utilize Cat-6 Cable.
- g. Acceptable Cable Manufacturers:
 - 1) Belden – 3600 Series Cat-6
 - 2) Berk-Tek – LANMark-1000
 - 3) CommScope – Systimax GigaSPEED XL
 - 4) General Cable – GenSpeed 6000
 - 5) Hitachi – Premium Cat-6
 - 6) Mohawk – AdvanceNet
 - 7) Superior Essex – DataGain Cat-6+
 - 8) Approved Equal

B. Twisted Pair Cable Hardware

1. Patch Panel

- a. Description: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables. Patch panels shall be rated to meet channel warranty requirements.
- b. Universal T568A and T568B wiring labels.
- c. Ports: 24 and 48 port as indicated on the project drawings
- d. Style: Flat
- e. Rear strain-relief bar.
- f. Labeling areas adjacent to conductors.
- g. Preloaded type panels.

2. Jacks (Information Outlets)

- a. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
- b. Marked to indicate transmission performance. Refer to project drawings for locations of Cat-6 and 6A Jacks.
- c. Designed to snap-in to a patch panel or faceplate.
- d. Standard: Comply with TIA-568-C.2.
- e. Provide keystone-style jacks as required in floor boxes, poke-thru's, modular furniture adapter plates, and other locations as required.

3. Faceplates

- a. Faceplates shall be designed with flush angled port openings to accept jacks and other outlets indicated on the Drawings.
- b. Faceplates shall not extend more than 0.25" from the face of the wall.

- c. Faceplates shall have an integrated label holder with clear plastic cover. Single gang faceplates shall have 2 integrated label holders with clear plastic covers; one shall be above the jacks and one shall be below the jacks. Double gang faceplates shall have 4 integrated label holders with clear plastic covers; two shall be above the jacks and two shall be below the jacks.
 - d. Color: Faceplates shall match adjacent electrical faceplates unless otherwise noted. Coordinate with Architect.
- 4. Modular Furniture Adapter Faceplates
 - a. Faceplates shall be designed for use within modular furniture.
 - b. Faceplates shall have an integrated label holder with clear plastic cover.
 - c. Confirm dimension of furniture knockout with proposed modular furniture adapter to ensure compatibility.
 - d. Color: black for dark furniture, ivory for light colored furniture.
- 5. Floor Box / Poke-Thru Adapter Plates
 - a. Coordinate with requirements of Division 26 as applicable.
 - b. Adapter Plates shall accept data jacks, A/V connectors, and other required connectivity devices as indicated on the drawings.
- 6. Surface Mount Boxes
 - a. 1-Port and 2-Port surface mount boxes as indicated on the project drawings.
 - b. Plenum rated as required.
 - c. Shall accept jacks from the same manufacturer as other components used throughout the project.
- 7. Modular Plug Termination Link (Direct Connect)
 - a. Standard: Conform to TIA-568.2-D, Annex F
 - b. Uses: Termination at end device including Wireless Access Points, CCTV Cameras, TV Displays, Projectors, and other devices as indicated on the project drawings.
 - c. Do not use unless specifically indicated to do so on the Project Drawings.
- 8. Consolidation Point
 - a. Consolidation point enclosures shall comply with ANSI/TIA-568.1D-2015, shall be plenum rated, 16 gauge steel, and shall be designed to house hardware necessary to terminate a minimum of 300-pair.
 - b. Units shall include knockouts with grommets capable of maintaining plenum rating of the enclosure once the cable has been installed.
 - c. Enclosures shall be painted a light color with textured powder paint.
 - d. Access doors shall be hinged and lockable and shall be reversible in the field.
- 9. Multiuser Telecommunications Outlet Assembly (MUTOA)
 - a. The MUTOA Boxes shall be 6 or 12 port surface mount boxes with all connections exiting one side of the box.
 - b. Each box shall accept individual connector modules that can be individually inserted and removed as required. All installed MUTOAs shall be marked with the maximum allowable length for the equipment cables.
 - c. Plenum rated as required.
 - d. Mounting: Recessed in ceiling.
- 10. Manufacturers:
 - a. Belden
 - b. CommScope
 - c. Hubbell
 - d. Leviton

- e. Ortronics
- f. Panduit
- g. Siemon
- h. Approved Equal

2.2 BACKBONE SUBSYSTEM

A. Indoor Rated Cable

1. Copper

a. Voice Riser

- 1) Copper riser cables (multipair) shall consist of solid copper conductors certified to meet transmission characteristics of Category 3 cable at frequencies up to 16MHz.
- 2) PVC sheath shall have improved frictional properties, allowing it to be pulled through conduit without the use of lubricants.
- 3) Cables shall be provided in the form of 25-pair, 50-pair, 100-pair, 150-pair, 200-pair, 300-pair, 400-pair, 600-pair, 900-pair, 1200-pair, 1500-pair, and/or 1800-pair as indicated on the project drawings.

2. Fiber

a. Laser Optimized 50-micron Multimode Fiber (OM4)

- 1) Maximum attenuation at 850 nm and 1300 nm: 3.0 dB/km and 1.0 dB/km.
- 2) Minimum modal bandwidth: 4700 MHz/km at 850 nm
- 3) Fiber Strand count as indicated on the Project Drawing Riser Diagrams.
- 4) Core diameter: 50 μm $\pm$ 3 μm .
- 5) Cladding diameter: 125 μm $\pm$ 12 μm .
- 6) Construction: Tight Buffer
- 7) Jacket: Dielectric Armored
- 8) Armor Material: Aluminum
- 9) Jacket Color: Aqua

B. Outdoor Rated Cable

1. Copper

- a. Copper cables (multipair) shall consist of solid copper conductors complying to RUS Specification PE-89 for use in underground conduit.
- b. Conductors: solid, annealed copper, 24 AWG unless noted on design documents.
- c. Insulation: Dual insulated with inner layer of foamed natural polyolefin covered by an outer layer of solid color polyolefin, color coded to industry standards.
- d. Twisted Pairs: Insulated conductors twisted into pairs with varying lay lengths to minimize crosstalk. Standard capacitance of 83 to 87 Nano farads per mile and a staggered twist design.
- e. Core Assembly: cables of 25 pairs and less formed by assembling pairs together in a single group. Cables of more than 25 pairs formed by twisted pairs arranged in groups with each group having a color coded unit binder.
- f. Filling Compound: core assembly completely filled with an 80 degree Celsius rated ETPR compound, filling the interstices between the pairs and under the core tape.

2. Shield:

- a. Inner shield: corrugated, copolymer coated, 8 mil aluminum tape applied longitudinally without an overlap. The sheath interfaces are flooded with an adhesive water blocking compound.

- b. Outer shield: corrugated, copolymer coated, 6 mil steel tape applied directly over the aluminum and overlays. The shield interfaces are flooded with an adhesive compound to provide a moisture barrier
 - c. Jacket: black, linear low density polyethylene.
 - d. Cables shall be provided in the form of 25-pair, 50-pair, 100-pair, 150-pair, 200-pair, 300-pair, 400-pair, 600-pair, 900-pair, 1200-pair, 1500-pair, and/or 1800-pair as indicated on the project drawings.
 - e. Manufacturers:
 - 1) General Cable
 - 2) Superior Essex
 - 3) Approved Equal
 - 3. Fiber
 - a. Cable shall be all-dielectric, stranded loose-tube design with dry water blocking for outdoor duct and aerial installations in fiber counts from two to 288 as indicated on the Project Drawings.
 - b. Each fiber shall be distinguishable by means of color coding in accordance with TIA-598-C, "Optical Fiber Cable Color Coding."
 - c. Jacket Color: Black
 - d. Singlemode
 - 1) Maximum attenuation at 1310 nm and 1550 nm: 0.4 dB/km and 0.3 dB/km.
 - e. Manufacturers:
 - 1) Berk-Tek
 - 2) Corning
 - 3) General Cable
 - 4) Optical Cable Corporation
 - 5) Superior Essex
 - 6) Approved Equal
- C. Twisted Pair Cable Termination Hardware
 - 1. 110-Style Copper Termination Block
 - a. Termination blocks shall be Category 5e component level compliant, and shall facilitate cross-connection and interconnection using either cross-connect wire (voice only) or patch cords.
 - b. Termination blocks shall be fire retardant, molded plastic consisting of horizontal index strips for terminating 25 pairs of conductors each. A series of fanning strips shall be located on each side of the block for dressing the cable pairs terminated on the adjacent index strips. Clear label holders with the appropriate colored inserts shall be provided with the termination blocks. The insert labels shall contain vertical lines spaced on the basis of circuit size (2-, 4-, or 5-pair) and shall not interfere with running, tracing, or removing jumper wire or patch cords.
 - c. Terminating blocks shall accommodate over 200 repeated insertions without incurring permanent deformation and shall pass the reliability test of no more than one contact failure in 10000 connections.
 - d. Terminating blocks shall be in 100-pair or 300-pair form. Termination blocks shall be able to accommodate #24 AWG conductors. Terminating blocks shall be UL listed.
 - e. The 110-termination block system shall include wiring block, standoff legs, and vertical/horizontal wire management on all sides of the termination blocks.
 - f. The 110 system shall also include (6) C-4's for 4 pair cable installations, and (5) C-5's for 25 pair wiring strip.
 - 2. Building Entrance Terminals (BETs):

- a. 16 AWG powder coated steel building entrance terminals.
 - b. Industry standard 110-Style Connector for both input and output terminals.
 - c. Connectors shall accept up to 22 AWG wire terminations.
 - d. Multiple external and internal ground lugs.
 - e. Stackable to allow for future expansion
 - f. Equipped with internal fuse link
 - g. UL497 approved.
 - h. Accommodates industry standard 5 Pin Protection Modules.
 - i. Manufacturers:
 - 1) Circa Telecom
 - 2) ITW Linx
 - 3) CommScope
 - 4) Vertiv
 - 5) Approved Equal
3. Patch Panel
 - a. Description: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables. Patch panels shall be rated to meet channel warranty requirements.
 - b. Universal T568A and T568B wiring labels.
 - c. Ports: 24 or 48 port as indicated on the project drawings
 - d. Style: Flat
 - e. Rear strain-relief bar.
 - f. Labeling areas adjacent to conductors
 - g. Preloaded type panels.

D. Fiber Optic Cabling Termination Hardware

1. Fiber Optic Enclosures:
 - a. Shall provide cross-connect, interconnect, and splicing capabilities and contain troughs for supporting and routing of the fiber cables and jumpers.
 - b. Shall consist of a modular enclosure with retainer rings in the slack storage section to limit the bending radius of fibers.
 - c. Shall have a window section to insert connector panels for mounting of connectorized fibers.
 - d. Shall provide capacity to accommodate quantity of terminations as indicated on the project drawings, plus 25% spare capacity for future growth.
 - e. Refer to Project Drawings for Wall-Mount and Rack-Mount requirements.
2. Fiber Connector Panels
 - a. Modular, quick-fastening steel plate, powder-coated to match the fiber enclosure finish.
 - b. Shall have a pre-installed array of fiber adapters of a specific connector type, available in low- or high-density versions.
 - c. Pre-installed, push-pull type quick-release fasteners for quick snap-in installation.
 - d. Suitable for mounting either vertically or horizontally.
 - e. Panels with LC adapters shall have precision phosphor-bronze alignment sleeves that are suitable for either singlemode or multimode transmission.
 - f. All fiber panels shall have dust caps installed.
3. Fiber Optic Connectors
 - a. Connector Pigtails
 - 1) Optical fiber pigtails shall be constructed with a fiber connector, factory terminated onto a cut length of 900 micron buffered fiber cable of specific color.
 - 2) Connector pigtail terminations shall be heat-cured epoxy type with a machine polish, inspected 100% for polish quality and mated-pair insertion loss.

- 3) Epoxy volume within each connector shall be sufficient to properly surround and strain relieve the buffer layer at the buffer/fiber transition inside the connector body.
 - 4) Pigtails shall be available in standard lengths of 3 meters.
 - 5) Connector shall be LC-Style
 - 6) Factory terminated connectors shall comply with the applicable ANSI/TIA-604 Intermateability standard.
4. Splices and Closures: The fiber splice module shall be utilized for all outside plant terminations. The link shall consist of the fiber cable, the splice, the splice tray holder/closure, the fiber panel/coupler, a pre-manufactured fiber pigtail with pre-polished fiber connector, and a fiber jumper to connect the pigtail-coupled link to the appropriate electronic switch. The fiber splice module shall meet the following specifications:
 - a. Fusion: Optical fiber splices shall not exceed a maximum optical attenuation of 0.3 dB when measured in accordance with ANSI/TIA-455-34, Method A (factory testing) or ANSI/TIA-455-59 (field testing). Optical fiber splices shall have a minimum return loss of 20 dB for multimode, 26 dB for single mode, when measured in accordance with ANSI/TIA-455-107.
 - b. All fusion splices shall be mounted in protective trays within the closure.
 - c. Joins single mode or multi-mode fibers
 - d. Establishes a permanent fusion splice
 - e. May be used in OSP and/or premises applications
 - f. Accept 250 and 900 micron fibers
 - g. Re-enterable, portable and reusable
 - h. Require no polishing
 - i. Require no adhesives
 - j. No loose parts
 - k. Unlimited shelf life

2.3 POWER OVER ETHERNET (POE/POE+) EXTENDER SYSTEM

A. Components

1. Hybrid Fiber / Copper Cable
 - a. Copper Conductor Size: 12AWG
 - b. Optical Fiber Strands: 02
 - c. Fiber Type: Singlemode
 - d. Jacket Type: Outdoor PE
 - e. Compatible with FOSC 450A Splice Closure
2. PoE Extender
 - a. Provides termination for hybrid cable input and automatically corrects voltage drop over distance.
 - b. Optical signal and power in must be converted to RJ45 PoE+ compliant jack.
 - c. Must use outdoor rated patch cord.
 - d. Extender shall have three (3) levels of electrical protection:
 - 1) Primary - GDT component rated to 40kA surge protection
 - 2) Secondary - MOV components rated to 4.5kA
 - 3) Tertiary - TVS prevents the voltage from rising above 80-100V
 - e. Termination block shall support a minimum of 200 re-terminations while maintaining a contact resistance of less than one (1) milliohm.
 - f. Environmentally sealed closure rated to IP67.
 - g. Must provide electrical power transmission management.
 - h. Shall be designed to fit inside brackets capable of holding various types access devices such as wireless access points, or universal mounting brackets.

3. Power and Fiber Distribution Element
 - a. Shall comply with NEC Class II and SELV.
 - b. Capable of extending maximum distance to 1.6 Km for PoE+ (30W output) and 3 Km for PoE (15W output).
4. Cable and fiber management panel
 - a. Must be rack-mounted style and provide separation and cable management for the power and optical fiber elements of the hybrid powered fiber cable.
 - b. Shall contain a fiber splice tray.
 - c. Must be equipped with LC or SC fiber connectors in front.
 - d. Shall contain terminal block for front access connection to Power Supply Unit (PSU) and circuit breakers.
5. Manufacturers
 - a. CommScope Powered Fiber Cable System (Basis of Design)
 - b. Berk-Tek One Reach

2.4 PATCH CORDS

A. Copper

1. Description: Factory-made, four-pair cables terminated with an eight-position modular plug at each end.
2. Modular data patch cords shall meet channel performance requirements specified herein, and shall be #24 AWG, stranded conductors insulated with solid polyolefin, tightly twisted into individual pairs and jacketed with flame retardant PVC.
3. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance.
4. Patch cords shall have latch guards to protect against snagging.
5. Field terminated patch cords are not acceptable.

B. Fiber

1. Description: Factory-made, dual-fiber cables with connectors as indicated.
2. The fiber optic patch cord will be consistent with termination type and fiber optic mode. (i.e. singlemode or multimode).
3. Field terminated patch cords are not acceptable.

C. Refer to Part 3 of this Section for a list of all patch cord types, quantities, colors and lengths to be provided.

D. Patch cords shall be provided as part of the warranted channel solution.

PART 3 - EXECUTION

3.1 GENERAL

- A. General installation means and methods shall comply with the most current editions of the BICSI Telecommunications Distribution Methods Manual and the BICSI Information Transport Systems Installation Methods Manual (ITSIMM).
- B. Ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities.
- C. Miscellaneous equipment: provide necessary screws, anchors, clamps, cable ties, distribution rings, miscellaneous grounding and support hardware necessary to facilitate the installation of the system.

- D. Special equipment and tools: furnish special installation equipment or tools necessary to properly complete the system, including tools for terminating, testing and splicing cables, jack stands for cable reels, and cable wenchers.
- E. Install plenum rated cables where cables are not installed in conduits or enclosed wireways.
- F. Install cables designed for the installation environment.
 - 1. For each cable distribution application, install fiber optic and copper cables UL listed for the application.
 - 2. For cable distribution applications including enclosures or raceways underground or in slabs on grade, install fiber optic and copper cables designed for use in wet locations.
- G. Jacks shall be wired per the pair assignments indicated in the ANSI/TIA-568.1D-2015 designation T568B wiring plan.

3.2 HORIZONTAL SUBSYSTEM

- A. Horizontal Cabling:
 - 1. Horizontal cables shall be installed in a star topology from each communications outlet to the Telecommunications room serving that area.
 - 2. The length of each horizontal cable from the Telecommunications room to the communications outlet shall not exceed 295'. Coordinate with the conduit and cable tray installation and modify as necessary to ensure distance requirements are not exceeded.
 - 3. Observe the bending radius and pulling strength requirements of the cables during handling and installation.
 - 4. Each run of cable between the termination hardware and the communications outlet shall be continuous without joints or splices.
 - 5. Conceal horizontal cables within ceilings and walls.
 - 6. Complete work above ceiling prior to ceiling tile installation.
 - 7. Provide detailed cable run diagrams for cable runs within raised floors detailing exact locations of cables.
 - 8. Refer to Section 270010, Communications General, for maintaining separation from EMI sources.
 - 9. Cabling routed above ceilings shall be supported using the following methods:
 - a. In cable tray above accessible ceiling where indicated on the Drawings.
 - b. In conduit where indicated on the Drawings. A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any conduit.
 - c. On J-hooks and/or Cable Straps, unless otherwise indicated on the Drawings. Cables shall be supported at a maximum of 48 to 60 inch intervals. At no point shall cable(s) rest on acoustic ceiling grids or panels.
 - 10. Cables, when not installed in conduit or cable tray, shall be bundled in groups of no more than 50 cables for Category 5e and 6, and no more than 24 cables for Category-6A. Cable bundle quantities exceeding these limits may cause deformation of the bottom cables within the bundle and degrade cable performance. Cable raceways shall not be filled greater than the ANSI TIA-569-A maximum fill for the particular raceway type or 40%. Cables shall not be attached to ceiling grid or lighting fixture wires.
 - 11. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
 - 12. Provide temporary protection of cables before termination. Cables shall not be left lying on the floor. Bundle and use Velcro or hook and loop tape to provide protection.
 - 13. Provide clutch or shear pin protection for cables during cable pulling to ensure cable pulling tension is not exceeded.
 - 14. Provide a 5'-7' service loop at the entrance of conduits that terminate at communications outlets.

15. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry. The cable jacket shall be maintained as close as possible to the termination point.
16. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels. If terminating a 25 or 50-pair cable (or 25-pair binder group of a larger pair-count cable) to a 24 or 48 port patch panel, the last pair (violet/slate) can be coiled unterminated at the rear of the patch panel.
17. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
18. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
19. At termination point of patch panels, install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
20. Furnish and install a horizontal cable manager below each patch panel in the Rack. Refer to Project Drawings for size of Wire Managers. Horizontal cable managers are not required below angled patch panels.
21. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the Owner.
22. Each cable shall be clearly labeled on the cable jacket behind the patch panel or termination block at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

B. Communications Outlets:

1. Communications outlets shall be formed from an assembly of faceplates and jacks as indicated on the Drawings.
2. Communications outlets installed in walls shall be installed in a double-gang box, with a single-gang plaster ring, terminating cables from the Telecommunications room.
3. Install outlets straight and perpendicular to walls and ceilings.
4. Secure faceplates with screws.
5. Label appropriately and cover each label with the clear plastic cover provided with the faceplate.

3.3 BACKBONE SUBSYSTEM

A. General

1. Run riser cables in a star topology, terminated in the main equipment room at one end and in the communications room at the other end unless otherwise indicated on the Drawings.
2. Observe the bending radius and pulling strength requirements of backbone cables during handling and installation.
3. At a minimum, provide a 15' maintenance coil at the origin and destination of each copper and fiber backbone. Each maintenance loops shall be neatly organized, mounted and labeled on the plywood backboard.
4. Install cable runway vertically from floor to ceiling in communications closets to support vertical cables. Strap cables to runways 3' on center.
5. Excavation and backfill: as specified in Section 270010, Communications General for OSP Cables.
6. Provide Velcro around cables to manage and support cable located 12" on center.
7. Provide distribution rings to support cable vertically and horizontally on plywood backboards. Install D-rings 12" on center.

B. Copper (Entrance Cables)

1. Provide lightning protectors and grounding conductors for the equipment and exposed incoming cable. Exposed cable shall be as defined in the BICSI Telecommunications Distribution Methods Manual.

2. For small pair count applications, provide electrical protection devices consisting of mounting panel for a series of balanced solid-state protector units and a wiring block and the protector units. Wiring blocks shall be used for input and output cable terminations. Insertion of the protector units into the mounting block shall complete the circuit. For 50-pair count and greater, provide protector panels and circuit protector modules.

C. Fiber

1. Place fiber-optic cable so as to maintain the minimum cable bend radius limits specified by the manufacturer.
2. Place fiber-optic cables transitioning between the cable trays and cabinets or racks in a neat and orderly manner per NEC 318.11(b) requirements and pathway requirements of TIA 569-A. Velcro transitioning bundles.
3. Secure the cables in the Communication Rooms with cable ties or straps as needed to prevent cables from sagging or becoming disorderly.
4. Follow manufacturer's installation instructions for connector installation.
5. Bring fiber optic cables into patch panels or cabinets at one location. Secure cables inside patch panels or cabinets at entrance points by securing fiber jackets. Break out individual fiber cables inside of panel or cabinet.
6. Fusion splices shall be located in attached splice trays.
7. Follow guidance of ANSI/TIA-568-C.3 regarding polarity management of fiber elements in the permanent link. Directly terminate fiber-optic on patch panels, in standard color code order.
8. Use connector manufacturer's recommended tools.
9. Fiber-optic connecting hardware and material including patch panels, connectors, cross-connect cables, patch cords, and other components used to connect fiber-optic cable shall be sourced from the same manufacturer.
10. Non-Armored Fiber cables shall be installed in innerduct.

3.4 POWER OVER ETHERNET (POE/POE+) EXTENDER SYSTEM

- A. Install all systems in accordance with manufacturer's printed instructions, as well as all local and state codes and standards.
- B. The power supply shall be installed in a safe location with access to the fiber optic network into which small cells or other network access devices are to be connected.
- C. Hybrid Cable shall be installed in underground conduit as required. Do not direct-bury cable.

3.5 PATCH CORDS

- A. Provide cross-connect wires, patch cords and fiber patch cords for cross-connection and interconnection of termination blocks, patch panels, and fiber optic cabinets.
- B. Furnish the following patch cords in the lengths, colors, and quantities listed below to the Owner. Confirm all lengths, colors, and quantities with Owner and/or Engineer prior to procurement.

Copper Patch Cords

Device	Type	Length	Color	Quantity
Work Area	Cat-6	10'	Gray	1 per Workstation drop
Wireless AP1	Cat-6A	5'	Yellow	1 per WAP. Plenum Rated as required.
CCTV Camera1	Cat-6	5'	Green	1 per Camera. Plenum Rated as required.
TR Patch (WAP)	Cat-6	7'	Blue	1 per Workstation drop
TR Patch (Wireless)	Cat-6A	7'	Yellow	1 per WAP
TR Patch (CCTV)	Cat-6	7'	Green	1 per Camera

¹ Patch Cords not required if using Modular Plug Termination Link (Direct Connect)

Fiber Patch Cords

Length	Color	Qty	Purpose
1-Meter	Aqua		Duplex LC- Duplex LC OM4
2-Meter	Aqua		Duplex LC- Duplex LC OM4
3-Meter	Aqua		Duplex LC- Duplex LC OM4
1-Meter	Yellow		Duplex LC- Duplex LC Singlemode
2-Meter	Yellow		Duplex LC- Duplex LC Singlemode
3-Meter	Yellow		Duplex LC- Duplex LC Singlemode

END OF SECTION 271000

SECTION 271100 – BROADBAND CABLING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section covers broadband cabling systems.
- B. Specialty systems general provisions are specified in Section 270010, Communications General.
- C. Specialty systems commissioning is specified in Section 270090, Communications Commissioning.
- D. Voice and data cabling systems are specified in Section 271000, Structured Cabling Systems.
- E. This Section includes responsibilities and obligations in support of the performance verification specified in Section 270090, Communications Performance Verification.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. ISO 9001-2015.
 - 2. North Carolina State Electrical Code-2018.

PART 2 - PRODUCTS

2.1 CABLES AND CONNECTORS

- A. Cables shall be designed for the installation environment.
 - 1. Fiber optic and copper cables shall be UL listed.
 - 2. Fiber optic and copper cables installed in enclosures or raceways underground or in slabs on grade shall be designed for use in wet locations.
- B. Series-6 (RG-6) Cables:
 - 1. Impedance: 75 ohms.
 - 2. Center conductors: #18 AWG solid copper-covered steel.
 - 3. Shield: combination aluminum and copper braid, quad shield type, 100% shield coverage.
 - 4. Rated to 1000 MHz, minimum.
 - 5. Maximum attenuation for nonplenum rated cable: 1.46 dB/100' at 50 MHz; 7.3 dB/100' at 1000 MHz.
 - 6. Maximum attenuation for plenum rated cable: 1.5 dB/100' at 50 MHz; 76.3 dB/100' at 1000 MHz.
 - 7. Manufacturer: Belden, Carol Brand/General Cable, CommScope, Liberty, or West Penn.
- C. Series-11 (RG-11) Cables:
 - 1. Impedance: 75 ohms.
 - 2. Center conductors: #14 AWG solid bare copper.
 - 3. Shield: combination aluminum and copper braid, quad shield type, 100% shield coverage.
 - 4. Frequency range: 5 MHz to 1000 MHz.
 - 5. Maximum attenuation for nonplenum rated cable: 0.95 dB/100' at 50 MHz; 4.8 dB/100' at 1000 MHz.
 - 6. Maximum attenuation for plenum rated cable: 1.2 dB/100' at 50 MHz; 5.6 dB/100' at 1000 MHz.
 - 7. Manufacturer: Belden, Carol Brand/General Cable, CommScope, Liberty, or West Penn.

D. Hard-Line Coaxial Cables:

1. Nominal diameter over outer conductor: 0.5".
2. Nominal inner conductor diameter: 0.109".
3. Nominal outer conductor thickness: 0.024".
4. Impedance: 75 ohms.
5. Maximum attenuation: 0.16 dB/100' at 5 MHz; 2.52 dB/100' at 1000 MHz.
6. Manufacturer: CommScope, Manhattan/Alpha Wire, or West Penn.

E. Coaxial Connectors:

1. Compression type.
2. Axial pull force strength: 40 lbf minimum.
3. Series-6 connectors shall be feed-through type.
4. Series-11 and hard-line connectors shall be pin type.

F. Patch Panels:

1. Functionally designed to mount in standard rack in compliance with EIA/ECA 310-E-2005.
2. Panel shall be modular type.
3. Shall be fully populated with "F" connector modules.
4. Integral labels.
5. Maximum ports: 24.
6. Provide horizontal cable manager above and below each patch panel.
7. Provide wall mount bracket with minimum 8" depth.

G. Outlet Faceplates:

1. Coaxial cable jacks shall be installed in voice and data outlet faceplates.
2. Faceplates shall not extend more than 0.25" from the face of the wall.
3. Faceplates shall have an integrated label holder with clear plastic cover.
4. Finish: black for dark walls, and white for light colored walls.

2.2 PASSIVE DISTRIBUTION DEVICES

A. General:

1. Dust and corrosion resistant die cast housing.
2. RF shielding.
3. Mounting tabs and grounding blocks.
4. Manufacturer: Blonder-Tongue, Cisco, R. L. Drake, or Pico Macom.

B. Splitters:

C. Frequency range: 5 MHz to 1000 MHz.

D. Allowable insertion loss at 400 MHz to 600 MHz:

1. 2-way: 4 dB maximum.
2. 3-way (balanced): 6.5 dB maximum.
3. 4-way: 7.8 dB maximum.
4. 8-way: 12 dB maximum.

E. Input return loss: 18 dB minimum.

F. Isolation between outputs: 20 dB minimum.

- G. Directional Couplers:
- H. Frequency range: 5 MHz to 1000 MHz.
- I. Input return loss: 18 dB minimum.
- J. Isolation between outputs: 20 dB minimum.

2.3 ACTIVE DISTRIBUTION DEVICES

- A. Broadband Distribution Amplifiers:
 - 1. Indoor type with removable covers.
 - 2. 120 V AC nominal input voltage with power supply.
 - 3. Two-way type with active return path.
 - 4. Forward bandwidth: 54 MHz to 750 MHz, minimum.
 - 5. Return bandwidth: 5 MHz to 36 MHz.
 - 6. Test port level: -30 dB $\pm$ 2 dB.
 - 7. Gain control range: 10 dB.
 - 8. Slope control range: 8 dB.
 - 9. Minimum forward gain: 32 dB.
 - 10. Minimum return gain: 20 dB.
 - 11. Terminal impedance: 75 ohms.
 - 12. Composite triple beat: -53 dB, minimum.
 - 13. Composite second order: -56 dB, minimum.
 - 14. Return loss: 16 dB, minimum.
 - 15. Noise figure: 8.5 dB, maximum at full gain.
 - 16. Hum modulation: -70 dB, minimum.
 - 17. Manufacturer: Blonder-Tongue, R. L. Drake, or Pico Macom.

PART 3 - EXECUTION

3.1 GENERAL

- A. The horizontal distribution topology shall be a star-topology consisting of continuous cable home-runs from the outlet to the designated communications room.
- B. The horizontal distribution shall not employ trunk-and-tap distribution methods. No splitters or couplers shall be utilized between the outlet and communications room.
- C. The passive distribution system will be rated for system bandwidth of 5 MHz to 1000 MHz.
- D. Active components shall be rated for system bandwidth of 750 MHz.
- E. System shall be designed with the appropriate active and passive distribution devices to achieve a signal strength of ± 9 dBmV (± 3 dB) at each outlet.

3.2 INSTALLATION

- A. Equipment Mounting:
 - 1. Mount distribution devices to the designated portion of the backboard in the communications room as indicated on the Drawings. Broadband distribution cables shall be terminated on wall-mounted patch panels at the broadband distribution backboard.

2. Mount distribution devices in the designated equipment racks or cabinets as indicated on the Drawings. Terminate broadband distribution cables on patch panels. Mount distribution devices using rack-mount hardware accessories or blank panels.

B. Cable Installation:

- C. Observe the bending radius and pulling strength requirements of cables during handling and installation.

- D. Provide distribution rings to support cable vertically and horizontally on plywood backboards. Install distribution rings 12" on center. Cable ties shall not be tight to the point of deforming the cable jackets.

- E. The following shall be considered guidelines for choosing cable types. The installing contractor shall be responsible for selecting the appropriate size cable to meet the required signal performance requirements.

1. Horizontal distribution: series-6 cable shall be used up to 250' and series-11 cable shall be used for longer runs.
2. Backbone distribution: series-11 cable shall be used at a minimum, unless otherwise indicated on the Drawings.

F. Passive Distribution Devices:

1. At each broadband distribution backboard or cabinet, provide a network of directional couplers and splitters designed to provide the signal level specified herein at each outlet location.

G. Active Distribution Devices:

1. Align and balance system as recommended by the manufacturer to achieve proper signal levels across the frequency range at each outlet. Provide equalizers, attenuators and other signal accessories as required.

H. Communications Outlets:

1. Outlets shall be formed from an assembly of faceplates and jacks as indicated on the Drawings.
2. Outlets installed in walls shall be installed in double-gang boxes, with single-gang plaster rings.
3. Install outlets straight and perpendicular to walls and ceilings.
4. Secure faceplates with screws.
5. Label appropriately and cover each label with the clear plastic cover provided with the faceplate.

3.3 GROUNDING AND BONDING

- A. Provide a ground bus bar at broadband distribution equipment location in each communications room, the service entrance room, and the main equipment room.
- B. Bond each ground bus bar to the main equipment room bus bar and then to the main electrical ground.
- C. Bond enclosures, cabinets, service boxes, and framework to this ground.
- D. Utilize grounding conductors sized to 2 kcmil per linear foot of conductor up to a maximum of #3/0 AWG.
- E. When two or more ground bars occur on each floor, provide an interconnecting bonding conductor between ground bars on the top floor and every third floor below.
- F. Grounding shall be in accordance with TIA/J-STD-607-D-2019 and local codes.

3.4 IDENTIFICATION

- A. Cables, regardless of length, shall be marked with preprinted, wrap-around number or letter cable markers at both ends. Markers shall be permanently affixed with heat-shrink tubing. There shall be no unmarked cables at any place in the system. Marking codes used on cables shall be indicated on the record drawings.
- B. Outlet faceplates shall be labeled.
- C. No labels shall be handwritten.

3.5 FIELD TESTING

- A. Provide functional test plan as required by Section 270090, Communications Commissioning.
 - 1. Include system signal source type and level to be utilized in testing.
- B. Measure the signal strength at each outlet to confirm the appropriate active and passive distribution devices to achieve the signal level specified herein.

END OF SECTION 271100

SECTION 274015 – AUDIO-VISUAL INFRASTRUCTURE AND RACEWAY

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions are specified in Section 260010, Electrical General, and other Sections of Division 26.
- B. This Section covers raceway and boxes to support the Audio-Visual-Systems described in other Sections and on the Drawings.

1.2 QUALITY ASSURANCE

- A. Conform to all codes and standards listed in PART 1 of Section 260010, Electrical General.
- B. This Section includes responsibilities and obligations in support of the Performance Verification specified in Section 260090, Electrical Performance Verification.

1.3 SUBMITTALS

- A. General submittal requirements as identified in Section 260010, Electrical General. In addition to those requirements, submittals for this Section shall include the following:
 - 1. Floor plans indicating box and raceway locations.
 - 2. Elevations of all walls where a specific dimension or spatial relationship between a box and another box, device, or building component is required.
 - 3. Manufacturer's submittal forms, or detail drawings when such a form is unavailable, for configurable boxes, such as multi-compartment floor boxes and poke-through devices with multiple options. The documentation submitted shall include all part numbers and options to be ordered with the configurable box.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. See Section 260010, Electrical General for additional requirements.
- B. Wall sleeves shall be galvanized rigid metal conduit or electrical metallic tubing.
- C. For floor slabs above grade, plastic core form block-outs shall be used.

2.2 PENETRATION SEALS

- A. Firestops:
 - 1. Refer to Section 078443, Joint Firestopping.
- B. Expansion Seals:
 - 1. Waterproof, modular, mechanical expansion type consisting of synthetic rubber grommets or interlocking links shaped to continuously fill the annular space between the penetrating item and the opening. Sizing of links and sleeve shall be determined by the manufacturer.

2. Manufacturer: Calpico Pipe Linx, Metraflex MetraSeal, Thunderline Link Seal.

C. Seal Assemblies:

1. Seal assemblies shall consist of a frame, compression mechanism, and insert modules. Assemblies shall be waterproof and shall be designed to allow easy addition or deletion of penetrating items.
2. Seal assemblies for multicable penetrations of fire and smoke rated construction shall comply with the requirements of firestops as specified herein.
3. Manufacturer: Nelson Multi-Plug.

2.3 ACCESS PANELS – BUILDING

- A. Access panels shall be flush type with concealed hinges. Frame shall be 16-gauge steel or extruded aluminum, and panel shall be 14-gauge steel. Provide flush screwdriver operated cam latches. key operated cylinder locks. Panels shall be finished for painting.
- B. Minimum size of panels shall be 12" H x 12" W for handholes, 18" H x 18" W elsewhere.
- C. Fire rated access panels shall be UL listed, and shall have 16-gauge steel frames, 20-gauge hollow steel door with fire resistive insulation, finished for painting, automatic closure springs, and key operated cylinder locks.
- D. Panels in inaccessible acoustical tile ceilings shall be designed to accept tiles.
- E. Manufacturer: Bar-Co, CESCO, J.L. Industries, Karp, Larsen's, Milcor, Nystrom.

2.4 HIGH TRAFFIC SLEEVES

- A. Rated for walls and above grade floor slabs.
- B. A self-contained firestop system that automatically adjusts to cable load.
- C. UL classified for use in wall and floor systems rated for up to 3 hours.
- D. Manufacturer: Abesco Cable Transit System, Specified Technologies EZ-Path, Wiremold FlameStopper.

2.5 RACEWAY, CABLE TRAYS, AND BOXES

- A. Raceways, cable trays, boxes, and related equipment shall be in accordance with applicable Division 26 Specification Sections.
- B. Wall Boxes:
 1. All wall boxes shall be deep, unless otherwise noted.
 2. Sizing and type as indicated on the Drawings.
- C. Cable Runways:
 1. Cable runways shall form a wireway system for cable management inside communications rooms. Runways shall include nominal 12" wide, steel construction, with endplates and dropouts. Runways shall be classified by UL as an equipment grounding conductor.
 2. Runways shall have 0.375" H x 1.5" W stringers rated for 42 lb/ft @ L/360 when supported at 6.0' intervals.

D. J-Hooks:

1. J-hooks shall be designed to support a minimum of 80 Category 6 cables, shall be steel, UL listed for a maximum static load of 50 lb, and shall be rated for use in plenum environments.

E. Audio-Visual Floor Boxes:

1. Refer to Audio-Visual Infrastructure Drawings for additional requirements.
2. Floor boxes shall be UL listed.
3. Floor boxes shall be designed for the type of floor in which they will be installed.
4. Floor boxes shall have temporary construction cover and finish cover as shown.
5. Floor boxes shall have separate UL-rated divisions (compartments) as shown on the Drawings.
6. Floor boxes shall be rated for on-grade applications where required by code.
7. Manufacturer: as shown on the Drawings.

F. Recessed Flat Panel Display Mount Boxes:

1. Functionally designed to recess a flat panel display swing-arm mount assembly within a wall and provide a connection point for high-voltage and low-voltage signals.
2. UL listed.
3. Color: black.
4. Dimensions as shown on the Drawings.
5. Conduit and gang-box knockouts as shown on the Drawings.
6. Weight capacity, excluding the mount assembly: 138 lbs.
7. Manufacturer: as shown on the Drawings.

G. In-Wall Audio-Visual Storage Boxes:

1. Functionally designed to provide storage space for small devices and provide a connection point for high-voltage and low-voltage signals.
2. UL listed.
3. Dimensions and construction as shown on the Drawings.
4. Integrated universal zip tie anchor points.
5. Integral receptacles and/or surge suppression devices as shown on the Drawings.
6. Color: as shown on the Drawings.
7. Conduit and gang-box knockouts as shown on the Drawings.
8. Trim ring (flange).
9. Cover as shown on the Drawings.
10. Manufacturer: as shown on the Drawings.

PART 3 - EXECUTION

3.1 GENERAL

- A. Unless otherwise noted, basis of design raceway identified herein or on the Drawings is in EMT trade sizes. If flexible metallic conduit is used, all conduits shall be upsized by one trade size.

3.2 SLEEVES

- A. Provide where conduits pass through elevated floor slabs if conduits are not a part of the slab pour and for future cable or conduit risers.
- B. Install in raised foundations at least 2.0" high.
- C. Provide where cables pass through walls and elevated floor slabs.

- D. Wall sleeves shall extend 4.0" from each side of the walls.
- E. Openings through slabs for busway risers shall be finished with a 4.0" W x 2.0" H curb around the opening.
- F. Sleeves shall be secured in place. Provide insulating bushings on both sides of sleeves for cables.
- G. Provide ground bushings on both sides of sleeves containing separate ground conductors.

3.3 PENETRATION SEALS

- A. General:
 - 1. Install in accordance with the manufacturer's published instructions to achieve ratings and classifications specified herein. A copy of these instructions shall be maintained and available on site.
 - 2. Any void or openings in floor constructions or penetrations of acoustically rated walls, except as specified herein, shall be filled by packing with fiberglass and caulking both ends 1.0" deep.
- B. Expansion Seals:
 - 1. Install to seal single conduit or cable penetrations of walls below grade.
- C. Seal Assemblies:
 - 1. Install to seal the penetration of walls below grade by multiple cables in the same opening.

3.4 ACCESS PANELS – BUILDING

- A. Where Audio-Visual work is concealed by walls or ceilings, or is inaccessible, provide an access panel to provide access for service and maintenance.
- B. Audio-Visual work located above ceilings is considered accessible if the ceiling is the accessible type and is arranged for access to the equipment.
- C. Fire rated access panels shall be provided in fire barriers, with ratings to match the construction fire rating.
- D. Access doors providing access to equipment access doors shall allow for service and maintenance of the intended equipment.
- E. Installation of access panels is specified under another Division.

3.5 HIGH TRAFFIC SEALS

- A. Where Audio-Visual work is concealed by walls or ceilings, or is inaccessible, provide an access panel to provide access for service and maintenance.
- B. Audio-Visual work located above ceilings is considered accessible if the ceiling is the accessible type and is arranged for access to the equipment.
- C. Fire rated access panels shall be provided in fire barriers, with ratings to match the construction fire rating.
- D. Access doors providing access to equipment access doors shall allow for service and maintenance of the intended equipment.

- E. Installation of access panels is specified under another Division.

3.6 RACEWAYS, CABLE TRAYS, AND BOXES

A. General:

1. Install raceways, cable trays, boxes, and related equipment in accordance with Section 260529, Hangers and Supports for Electrical Systems, Section 260533, Raceways and Boxes for Electrical Systems, Section 260536, Cable Trays, and Section 260539, Underfloor Raceways for Electrical Systems.
2. Install wiring or cables in raceways where wiring or cables are installed underground, in concrete, and concealed in walls or in inaccessible ceilings, unless otherwise specified herein.
3. Install wiring or cables in raceways where wiring or cables are otherwise exposed, including open ceiling spaces.

B. Cable Runways:

1. Provide ground straps between each section and ground the runway to the ground bus bar.

C. J-Hooks:

1. Install maximum 5.0' on center.
2. Attach J-hooks to the structure as recommended by the manufacturer, except that J-hooks shall not be installed using drop wires or ceiling support wires. J-hooks shall not be connected to ceiling supports, utilities, or equipment.

D. Recessed Flat Panel Display Mount Wall Boxes:

1. Provide trim ring (flange).
2. Install per manufacturer's instructions.
3. Provide blocking as required to support future display. Coordinate with Architect.
4. Frame around box to maintain acoustical rating of walls. Coordinate with Architect.
5. Install conduit and gang-boxes as shown on the Drawings.
6. Install per other requirements as shown on the Drawings.

E. In-Wall Audio-Visual Storage Boxes:

1. Provide trim ring (flange).
2. Install per manufacturer's instructions.
3. Frame around box to maintain acoustical rating of walls. Coordinate with Architect.
4. Install conduit and gang-boxes as shown on the Drawings.
5. Install per other requirements as shown on the Drawings.

3.7 PERFORMANCE VERIFICATION

- A. Performance Verification of these systems shall be performed in conjunction with the Performance Verification requirements in Section 260090, Electrical Performance Verification.
- B. Performance Verification of the equipment included herein shall be conducted in accordance with requirements in other Specification Sections that cover related equipment.

END OF SECTION 274015

SECTION 274126 – PROJECTION SCREENS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions are specified in Section 260010, Electrical General, and other Sections of Division 26.
- B. This Section covers projection screens and related equipment.
- C. Power provisions, raceways, and boxes are indicated on the Electrical Drawings. Provide additional power provisions, raceways, and boxes, beyond those indicated in the above referenced Drawings, as required to accommodate the system configuration.
- D. The Contractor shall be responsible for providing all equipment, accessories, parts, and supplies as necessary to deliver complete and working systems as defined herein. Any equipment list or bill of materials included in the Contract Documents is for reference only and is not necessarily an exhaustive list of all components required to make the systems complete and operational. The Contractor shall be required to amend any such document or provide their own equipment list or bill of materials. Any equipment list or bill of materials provided by the Contractor shall not constitute a complete list of all equipment and supplies the Contractor intends to provide. Such a document shall not alleviate the Contractor from providing any and all necessary equipment and supplies beyond that which is on said equipment list or bill of materials to make the systems described herein and on the Drawings complete and operational.
- E. The term “Basis of Design,” shall be defined as a device representing the benchmark or minimum requirements in the Contract Documents for this Project. This shall not be interpreted as a sole-source requirement.

1.2 QUALITY ASSURANCE

- A. Conform to all codes and standards listed in PART 1 of Section 260010, Electrical General.
- B. This Section includes responsibilities and obligations in support of the Performance Verification specified in Section 260090, Electrical Performance Verification.
- C. AVIXA 10-2013, Audio-Visual Systems Performance Verification.
- D. AVIXA 2012, Audio-Visual Implementation Handbook.
- E. ISO 9001-2015.

1.3 SUBMITTALS

- A. General submittal requirements as identified in Section 260010, Electrical General. In addition to those requirements, submittals for this Section shall include the following:
- B. Floor Plans and/or RCPs showing the location of each projection screen and projection screen control device.
- C. The projection screen manufacturer’s submittal form completed specifically for this Project. When this scope includes multiple projection screens, one submittal form shall be submitted for each screen and shall indicated the space in which that screen will be installed.

- D. Drawings showing connections to suspension systems and details showing the screen's anchoring to structure.
- E. Details of juncture of exposed surfaces with adjacent finishes.
- F. Submittals are required before installation or fabrication begins. The Contractor shall not procure any equipment or perform any fabrication on any portion of this scope that has not received approval as defined herein. The Contractor shall be responsible for any costs related to returning, replacing, or not using any component of this scope that is ordered, fabricated, or installed prior to receiving such approval. Pay requests will not be approved for any work performed without approved Submittals.
- G. Dimensioned shop drawings of all fabricated, custom, or modified hardware, components, or devices. Provide a finish sample for all exposed finishes.
- H. Drawings are diagrammatic in nature and, unless explicitly dimensioned, indicate approximate locations of equipment and components. Changes in the location and offsets of the same, which are not shown on the Drawings but are necessary in order to accommodate building conditions and coordination with the work of other trades, shall be made during the production of shop drawings and prior to initial installation, without additional cost to the Owner.
- I. Provide access to equipment and components requiring operation, service, or maintenance within the life of the system.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Unless otherwise specified herein, quantities of equipment are indicated on the Drawings, and performance values specified herein are minimum acceptable values.
- B. All projection screen shall be from a single manufacturer, unless otherwise noted on the Drawings.
- C. See the Projection Screen Schedule on the Drawings for additional requirements.
- D. All products shall be UL listed.
- E. Manufacturer: Da-Lite, Draper, DNP, Stewart Filmscreen.

2.2 FRONT PROJECTION SCREENS

- A. Material and Viewing Surfaces:
 - 1. Screen fabrics shall be mildew resistant and shall be flame resistant in accordance with NFPA 701-2019.
 - 2. Viewing surfaces shall be seamless unless otherwise indicated on the Drawings.
 - 3. Edge treatments shall be black masking borders unless otherwise indicated on the Drawings.
- B. Electrically Operated Front Projection Screens:
 - 1. Screens shall be mounted such that the top edge of the fabric is securely anchored to a rigid metal roller and the bottom edge is formed into a pocket holding a weighted metal rod with the ends of the rod protected by plastic caps.
 - 2. Provide tab-tensioning where indicated on the Drawings.

3. Provide additional black drop as required to achieve desired viewing height as indicated on the Drawings.
4. Each screen shall include case, screen motor, controls, mounting accessories, and any other necessary components for a complete installation.
5. Provide three stage low voltage controller capable of raising, lowering, and stopping screen travel. Low voltage switch shall be a three-button keypad with cover plate at locations indicated on the Drawings.
6. Provide low voltage control connections to the Audio-Visual control system where shown on the Drawings.
7. Motors shall be instant-reversing, gear-drive, end-mounted type with permanently lubricated ball bearings, automatic thermal overload protection, preset limit switches to automatically stop the screen in up and down positions, and positive stop action to prevent coasting.

PART 3 - EXECUTION

3.1 GENERAL

- A. Provide all necessary incidental equipment or devices to deliver a complete and operable system.
- B. Verify correctness of parts lists and equipment model numbers and conformance of each component with manufacturer's specifications.
- C. Equipment shall be installed in accordance with the manufacturer's instructions.
- D. Equipment, except portable equipment, shall be held in place. This shall include equipment, enclosures, components, and cables. Fastenings and supports shall support their loads with a safety factor of at least 3 unless otherwise specified herein.
- E. Prevent and guard against electromagnetic and electrostatic hum and install the equipment to provide safety for the operator.
- F. Repair or replace any equipment or materials damaged during the construction or installation period.
- G. Provide power connections as required.
- H. Cut and repair walls and ceilings, including inaccessible and tile grid systems, as required to install the projection screens.
- I. Coordinate layout and installation of projection screens with other construction supported by, or penetrating through, ceilings, including luminaries, HVAC equipment, fire protection systems, and partitions.
- J. Projection screens shall not be supported by or suspended from any other building system, including but not limited to HVAC equipment, plumbing, telecommunications equipment, raceway, or fire protection equipment.
- K. Initial projection screen delivery and installation shall include only the projection screen case and mounting hardware. Install the case when the building is enclosed and other construction within spaces where screens will be installed is substantially complete. Deliver and install the roller assembly, motor, and fabric at a time when the building is dust-free. Coordinate with other trades as required.
- L. Coordinate and verify with the Architect the screen size, black drop, height of the bottom of viewing area, case mounting height and configuration, mounted depth, and required edge tolerances with construction of wall recesses to house screens prior to ordering screens that are mounted in walls.

- M. Coordinate requirements for blocking and structural supports to ensure adequate installation of screens.
- N. Prior to installation of electrically operated screens, verify the type and location of the power supply.
- O. Install projection screens at locations indicated on the Drawings and comply with the projection screen manufacturer's written instructions and shop drawings.

3.2 FRONT PROJECTION SCREENS

- A. Install manually and electrically operated front projection screens with screen cases in position and relationship to adjoining construction indicated on the Drawings. Securely anchor to supporting substrate in a manner that produces a smoothly operating screen with vertical edges plumb and viewing surface flat when screen is lowered.
- B. Adjust limit switches to ensure correct positioning, screen tensioning, and silent screen case opening and closure.
- C. Test electrically operated units to verify that screen, controls, limit switches, closure, and other operating components function.
- D. Provide access to equipment requiring connections or service within the life of the assembly.

3.3 PROJECTION SCREENS PERFORMANCE VERIFICATION

- A. Performance Verification of these systems shall be performed in conjunction with the Performance Verification requirements in Section 260090, Electrical Performance Verification.
- B. Performance Verification of the equipment included herein should be conducted in accordance with requirements in other Specification Sections that cover related equipment.
- C. Verify that projection screens are installed level and flat.
- D. Verify that no extraneous noise is made by any component of the projection screen assembly as the tensioning bar at the bottom of the screen enters or exits the screen case.
- E. Verify that the viewing surface is square and not contorted in any way.
- F. Where projection screens are recessed in a tile grid ceiling, verify that the grid is properly installed around the case and tiles are cut as necessary.
- G. Verify that projection screens descend to the proper viewing height and retract completely into the case, without extraneous noise.
- H. Verify that projection screen switches operate the intended functions (i.e., UP, DOWN, and STOP).

END OF SECTION 274126

SECTION 283010 - FIRE DETECTION AND ALARM GENERAL

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Refer to the General and Supplementary Conditions and Division 01 for special requirements and conditions which apply to all Sections of Division 28.
- B. These fire alarm and detection general provisions apply to the following:
 - 1. Section 283100, Fire Alarm System.
 - 2. Section 283200, Air Sampling Smoke Detectors.
 - 3. Section 283300, Rescue Assistance Communication System.
 - 4. Section 283400, Emergency Responder Radio Coverage System.
- C. This Section includes responsibilities and obligations in support of the performance verification in Section 283090, Fire Detection and Alarm Performance Verification and general commissioning requirements.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. North Carolina State Electrical Code-2017.
 - 2. NFPA 72-2013.
- B. Codes, standards and regulations referred to are minimum standards. Where the requirements of these specifications or drawings exceed those of the codes, standards and regulations, the drawings or specifications govern.
- C. Low-Emitting Materials
 - 1. Adhesives, sealants, sealant primers, paints, and coatings used inside the building (defined as inside the weatherproofing envelope and applied on-site) shall be tested and determined compliant with California Department of Public Health (CDPH) Standard Method v1.2-2017, using the applicable exposure scenario.
 - 2. Methylene chloride and perchloroethylene shall not be intentionally added in paints, coatings, adhesives, or sealants that are applied on-site.
 - 3. All paints and coatings that are wet-applied on site and used inside the building must meet the applicable VOC limits of one of the following:
 - a. California Air Resources Board (CARB) 2019, Suggested Control Measure (SCM) for Architectural Coatings
 - b. South Coast Air Quality Management District (SCAQMD) Rule 1168, 2017.
 - 4. All adhesives and sealants that are wet-applied on site and used inside the building must meet the applicable chemical content requirements of SCAQMD Rule 1168, 2017.
 - 5. All exterior applied adhesives, sealants, coatings, and waterproofing materials must meet VOC content limits of BOTH of the following:
 - a. California Air Resources Board (CARB) 2019 Suggested Control Measure (SCM) for Architectural Coatings
 - b. South Coast Air Quality Management District (SCAQMD), Rule 1168, 2017.
 - c. Small containers of adhesives and sealants subject to state or federal consumer product VOC regulations are exempt.
 - d. Paint that is applied on site shall not contain lead or any intentionally added cadmium.

1.3 SPACE CONDITIONS

- A. Drawings are diagrammatic in nature and, unless explicitly dimensioned, indicate appropriate locations of apparatus, equipment and raceways. Changes in the location, and offsets, of same to accommodate building conditions and coordination with the work of other trades, shall be made during the preparation of coordination drawings and prior to initial installation, without additional cost to the Owner.
- B. Locations of motors, starters, equipment and apparatus as indicated on the Drawings are approximate; connections shall be made to such equipment as actually installed.
- C. Provide access to equipment and apparatus requiring operation, service or maintenance throughout the life of the system.
- D. Install fire alarm panels such that no piping, ductwork or mechanical equipment is installed in the space equal to the width and depth of the equipment from floor to structure above. In addition, fire alarm panels shall be installed such that the working space in front shall be a minimum depth of 42" horizontally, the width of the equipment or 30", whichever is greater, and the height of the equipment or 78", whichever is greater.

1.4 ENVIRONMENTAL AIR-HANDLING SPACES

- A. Electrical power conductors installed in environmental air-handling spaces shall be approved for installation in plenum areas.
- B. Communications, data, control, and signal cable not in conduit or enclosed wireways shall be approved for installation in plenum areas.

1.5 ASBESTOS MATERIALS

- A. Materials containing asbestos or any trace of asbestos related materials shall not be used on this Project.

1.6 DEFINITIONS

- A. Exposed raceways are those which can be seen when the base building and tenant fit-up is complete without opening or removing access doors or panels or accessible ceiling components.
- B. Other raceways are considered to be concealed.

1.7 RELATED WORK DESCRIBED IN OTHER DIVISIONS

- A. Building control system.
- B. Cutting, coring, waterproofing, and patching of walls, floors, ceilings, roofs and structure of existing buildings.
- C. Elevators.
- D. Fire suppression systems.
- E. Heating, ventilating and air conditioning systems.
- F. Installation of access panels in wall and ceiling construction.

- G. Kitchen and food serving equipment.
- H. Painting, except as specified herein.
- I. Power-operated doors.
- J. Sprinkler waterflow and valve monitor switches.

1.8 SUBMITTALS

- A. After notice to proceed, submit a schedule indicating the proposed submission date of each submittal specified herein. Schedule shall anticipate the submittal review time, the possible need for resubmittals, and the time required for fabrication, shipping and integration into the construction sequence. Architect will advise of any conflicts in reviewing submittals that the proposed schedule presents.
- B. Submittals shall be prepared in a line-by-line format corresponding to these Specifications and shall indicate compliance with each requirement specified herein and indicated in the Drawings.
 - 1. In addition to any other transmittal or cover sheet used, fill out and attach to each individual submittal a copy of the Cover Sheet for Submittals to Newcomb & Boyd included at the end of this Section.
 - 2. Indicate manufacturer's installation instructions.
 - 3. Indicate deviations, if any, including any from the manufacturer's installation instructions.
 - 4. Reproductions or electronic versions of design drawings shall not be used in the preparation of shop drawings.
 - 5. Resubmittals that are required to address review comments shall include a cover transmittal with a written explanation of how each review comment has been addressed.
 - 6. Submittals not specifically required, or not complying with the format requirements, will be returned unreviewed.
 - 7. Shop drawings and submittals shall be provided in portable document format (PDF). PDF files containing multiple drawings or components shall include an index of the file contents and electronic bookmarks.
- C. Submittals shall include the following:
 - 1. Rescue assistance communication system.
 - 2. Performance verification supervisor qualifications.
 - 3. Fire alarm system.
 - 4. Seismic restraint devices, including calculations, restraint selection, installation details and written confirmation that a licensed engineer prepared the calculations.

1.9 EQUIPMENT AND INSTALLATION REQUIREMENTS

- A. Devices, equipment and materials, except as otherwise specified herein, shall be new and shall be of the customary standard and quality furnished by the designated manufacturer for that catalogue number.
- B. Materials and equipment shall be UL listed, and shall bear the UL listing mark on products for which standards have been established and for which listing is regularly furnished by UL.

PART 2 - PRODUCTS

2.1 SEISMIC RESTRAINTS

- A. Seismic force design shall be determined in accordance with the following seismic design criteria:
 - 1. Seismic Design Category: D.
 - 2. Risk Category: IV.
 - 3. Component Importance Factor, I_p : 1.5.
- B. Provide restraint devices as required for fire detection and alarm components. Provide calculations to determine restraint loadings for specific equipment to be installed resulting from seismic forces on equipment. Seismic restraint calculations shall be signed by a licensed engineer in the employ of the seismic restraint device manufacturer.
- C. For roof-mounted equipment and components the seismic acceleration load shall be calculated and utilized for the design of the seismic restraints.
- D. Exceptions for fire detection and alarm components listed within the applicable project building code may be utilized. However, use of exceptions shall be noted with submitted seismic restraint calculations.
- E. Seismic restraints provided with integral seismic restraint capacity shall have Anchorage Preapproval "R" Number from OSHPD in the State of California listing minimum certified horizontal and vertical load ratings.
- F. Suspended Restraints:
 - 1. Restraints for nonvibration isolated suspended equipment, conduit, and raceways shall consist of steel angle or unistrut with anchor bolts and end connection fittings designed to swivel to the final installation angle.
 - 2. Manufacturer: B-Line, International Seismic Application Technology, Kinetics Noise Control, Mason, Tolco, VMC Group, Vibration Eliminator, or Vibro-Acoustics.

2.2 CONCRETE

- A. Normal weight concrete (145 pcf) using Type I Portland Cement, 1" maximum size coarse aggregate to provide a minimum 28 day compressive strength of 3000 psig.

2.3 GROUT

- A. Nonshrink type, conforming to ASTM C1107/C1107M-2017 when tested at fluid consistency. Grout shall exhibit zero bleeding at every age when mixed to fluid consistency. Minimum 28 day compressive strength, when mixed to fluid consistency, shall be 7000 psig.
- B. Manufacturer: Cormix, or Master Builders.

2.4 ACCESS PANELS - BUILDING

- A. Refer to Section 083113, Access Panels.

2.5 SLEEVES

- A. Wall sleeves shall be galvanized rigid metal conduit or electrical metallic tubing.

- B. For floor slabs above grade, plastic core form block-outs shall be used.

2.6 PENETRATION SEALS

A. Firestops:

1. Refer to Section 078443, Joint Firestopping.

B. Expansion Seals:

1. Waterproof, modular, mechanical expansion type consisting of synthetic rubber grommets or interlocking links shaped to continuously fill the annular space between the penetrating item and the opening. Sizing of links and sleeve shall be determined by the manufacturer.
2. Manufacturer: Calpico Pipe Linx, Metraflex MetraSeal, or Thunderline Link Seal.

C. Seal Assemblies:

1. Seal assemblies shall consist of a frame, compression mechanism, and insert modules. Assemblies shall be waterproof and shall be designed to allow easy addition or deletion of penetrating items.
2. Seal assemblies for multicable penetrations of fire and smoke rated construction shall comply with the requirements of firestops as specified herein.
3. Manufacturer: Nelson Multi-Plug.

2.7 UNDERGROUND WARNING TAPE

- A. Tape shall be acid- and alkali-resistant polyethylene film tape, 6" wide with minimum thickness of 0.004", specifically designed for marking and locating of underground utilities.
- B. Tape shall be manufactured with integral wires, foil backing or other means to enable detection by metal detectors when the tape is buried up to 3' deep. The metallic core of the tape shall be encased in a protective jacket or provided with other means to protect it from corrosion.
- C. Tape color shall be orange and shall bear a continuous printed inscription describing the specific utility.
- D. Manufacturer: Brady, Boddingtons, Carlton Industries, Seton, or Thor Enterprises.

2.8 IDENTIFICATION MATERIALS

- A. Conduit markers: self-adhesive vinyl tape, minimum 3 mil thick x 1.5" wide, color-coded orange unless otherwise indicated on the Drawings.
- B. Tags: preprinted or partially preprinted accident prevention and operational tags, on plasticized card stock with matte finish for writing, approximately 3.25" x 5.625", with brass grommets and wire fasteners, and appropriate wording.
- C. Signs: 14" x 10" size, 0.04" thick aluminum base with baked enamel finish for indoor or outdoor use.
- D. Nameplates and Labels:
 1. White core plastic laminate with engraved lettering.
 2. Nameplate background color shall be black for normal power equipment and red for emergency power equipment.
 3. Nameplates for individual devices shall have 0.25" high letters.
 4. Nameplates for panels and equipment shall have 0.5" high letters.
 5. Labels shall have minimum 0.25" high letters.

2.9 MISCELLANEOUS

- A. Diagram framing system: 0.125" thick acrylic with satin finish aluminum frames.

2.10 PAINTING

- A. Paint for high temperature equipment shall be high temperature-resistant, designed for the temperatures at which the equipment will operate.

PART 3 - EXECUTION

3.1 PROTECTION OF EQUIPMENT AND MATERIALS DURING CONSTRUCTION

- A. Provide protective covers, skids, plugs or caps to protect equipment and materials from damage or deterioration during construction.
- B. Store equipment and material under cover, and off the ground or floors exposed to rain.
- C. For outdoor storage, protective covers of 10 mil thick black sheet plastic shall be fitted over equipment and materials. Covers shall be reinforced to withstand wind and precipitation. Set equipment and material on skids or platforms of height to avoid damage or deterioration from spattering and ground water.
- D. Provide dust and debris protection for devices and equipment operated during construction.

3.2 EQUIPMENT AND INSTALLATION REQUIREMENTS

- A. Cut and repair walls, floors and ceilings for the installation of the fire detection and alarm work.
- B. Exterior building walls below grade shall not be pierced by hanger bolts.
- C. Except where specific instructions are included herein, install and connect equipment in accordance with the manufacturers' instructions and recommendations.
- D. Refer to manufacturer's or equipment supplier's shop drawings for exact type, number, location, dimensions and size of connections to equipment, including but not limited to:
 - 1. Fire suppression equipment.
 - 2. Heating, ventilating, and air conditioning equipment, including power supplies to automatic temperature control systems.
 - 3. Kitchen equipment.
 - 4. Vertical transportation equipment.
- E. Coordinate the location of fire detection and alarm equipment in elevator machine rooms with the approved elevator machine room shop drawings.

3.3 SEISMIC RESTRAINTS

- A. Restraints shall be installed after the equipment is mounted, connected, and operating to ensure that no contact occurs during normal equipment operation.
- B. Installation of seismic restraints shall not cause any change of position of equipment, conduit, or raceways, resulting in stress and misalignment.

- C. Do not brace a system to two different structures, such as a wall and a ceiling.
- D. After installation, manufacturer shall verify that seismic restraints are installed and operating properly, and shall submit a certificate so stating.

3.4 ACCESS PANELS - BUILDING

- A. Where fire detection and alarm work is concealed by walls or ceilings, or is inaccessible, provide an access panel to provide access for service and maintenance.
- B. Fire detection and alarm work located above ceilings is considered accessible if the ceiling is the accessible type and is arranged for access to the equipment.
- C. Fire rated access panels shall be provided in fire barriers, with ratings to match the construction fire rating.
- D. Access doors providing access to equipment access doors shall allow for service and maintenance of the intended equipment.
- E. Installation of access panels is specified under another Division.

3.5 SLEEVES

- A. Provide where conduits pass through elevated floor slabs if conduits are not a part of the slab pour, and for future cable or conduit risers.
 - 1. Install in raised foundations at least 2" high.
- B. Provide where communications and other cables, not installed in conduits, pass through walls and elevated floor slabs.
- C. Wall sleeves shall extend 4" from each side of the wall.
- D. Sleeves shall be secured in place. Provide insulating bushings on both sides of sleeves for cables.
- E. Provide ground bushings on both sides of sleeves containing ground conductors.

3.6 PENETRATION SEALS

- A. General:
 - 1. Install in accordance with the manufacturer's published instructions to achieve ratings and classifications specified herein. A copy of these instructions shall be maintained and available on site.
- B. Firestops:
 - 1. Close and firestop penetrations through fire- and smoke-rated construction. Materials used to seal these penetrations shall continue the construction's fire and smoke resistance ratings uninterrupted and shall maintain an effective barrier against the spread of flame, smoke, water and hot gases.
 - 2. Install after installation of raceways.
- C. Expansion Seals:
 - 1. Install to seal single conduit or cable penetrations of walls below grade.

D. Seal Assemblies:

1. Install to seal the penetration of walls below grade by multiple cables in the same opening.

3.7 PAINTING

- A. Except where otherwise specified herein, painting shall be done under another Division. Surfaces shall be left clean and free from oil.
- B. Equipment factory finishes damaged or deteriorated during construction shall be repaired to match original finish.
- C. Where galvanizing is broken during fabrication or installation, recoat exposed areas with zinc-rich paint.
- D. Exterior ferrous equipment and supports shall be painted 2 coats of rust preventive paint, color selected by the Architect.
- E. Interior ferrous equipment, and nongalvanized ferrous accessories and metal shall be prepared and painted 1 coat of corrosion resisting paint prior to other painting or identification, or 2 coats of corrosion resisting paints if no other painting is specified herein.

3.8 COORDINATION

- A. Provide offsets, transitions, and fittings to coordinate the work of each trade with that of other trades, including HVAC, plumbing, fire suppression, electrical, communications, structural, and architectural.

3.9 UNDERGROUND WARNING TAPE

- A. During backfilling, install tape continuously at 6" to 8" below finished grade, above buried power, communications, or signal cables and conduits.
- B. Install multiple markers where cables are installed in groups exceeding 16" width.

3.10 CLEANING

- A. Equipment and Equipment Rooms:
 1. Remove dust, dirt, rust, stains, and temporary covers.
 2. Foreign matter shall be blown, vacuumed, flushed, or cleaned out of and from equipment, raceways, devices, controls and panels.
 3. Clean and polish identification plates.
 4. In equipment rooms, clean equipment, conduit, and room surfaces from dust and dirt and maintain in a clean condition from date of the Architect's final certificate until final completion of work and corrective work.
 5. Remove excess material from Project site.

3.11 IDENTIFICATION

- A. General:
 1. Identification shall consist of upper case letters.
 2. Where identification is applied to surfaces which require a finish, identification shall be installed after surface has been finished.

- B. Conduit Markers:
 - 1. Install on conduits and raceways exposed or above ceilings at connections to junction boxes, pull boxes, equipment, each side of wall, floor, and roof penetrations, and at 50' intervals along straight runs.
 - 2. On parallel conduits (grouped), markers shall be placed on each conduit in line with each other. Markers shall be positioned in such a manner as to ensure visibility.
- C. Cable identification: install cable identification on each communication or signal cable.
- D. Danger signs: install in areas constituting a danger for persons in or about the Project.
- E. Install a nameplate on the fire alarm panel to indicate the panel and circuit number supplying the fire alarm system.

3.12 OPERATION AND MAINTENANCE DOCUMENTATION PACKAGE

- A. These operation and maintenance manual requirements supplement operation and maintenance manual documentation requirements of other Sections of these specifications.
- B. Operation and maintenance documentation, in hardback 3-ring loose-leaf binders except full size drawings and CDs, shall cover the fire detection and alarm systems. Documentation shall include the following: operation and maintenance documentation directory; emergency information; operation manual; maintenance manual; test reports; and construction documents.
- C. The operation and maintenance documentation package shall be submitted as one comprehensive package to the Owner 3 months before systems start-up, and shall be updated, revised and completed at completion of construction.
- D. Documentation shall be typewritten and shall contain, at a minimum, the following information.
 - 1. Introduction:
 - a. Project name, contractors' and subcontractors' names, addresses, and telephone and facsimile numbers.
 - b. Index.
 - 2. Operation and Maintenance Documentation Directory:
 - a. Explanation of the identification system used, including lists of systems, equipment and component identifiers and names.
 - 3. Emergency Information:
 - a. Information for technical and nontechnical personnel about actions recommended during emergency situations to protect life and property and to minimize disruption to the building occupants. Emergencies shall, at a minimum, include:
 - 1) Fire.
 - 4. Operation Manual:
 - a. General Information:
 - 1) Building function.
 - 2) Building description.
 - 3) Operating standards and logs.
 - b. Technical Information:
 - 1) System description.

- 2) Operating routines and procedures.
 - 3) Routine operational testing program and procedures.
 - 4) Special procedures.
 - 5) Basic troubleshooting.
5. Maintenance Manual:
 - a. Descriptions (specifications) of the equipment and components.
 - b. Description of function, as applicable: the function of the equipment, procedures before start-up, functional parameters (input, output) at the design load and at part loads, and performance verification procedures.
 - c. Recommended maintenance procedures and their recommended frequency for this Project.
 - d. Name, address and contact of at least one qualified service company.
 - e. Recommended list of spare parts, part numbers, and the place(s) from which they can be obtained.
 - f. Original purchase order number; date of purchase; name, address, and the telephone number of the vendor; and warranty information.
 - g. Installation information.
 - h. Any other information needed for the preparation of documents supporting the management of operation and maintenance programs.
6. Test Reports and Certifications:
 - a. Copies of tests and certifications performed during manufacture and construction including, but not limited to, the following:
 - 1) Certification of fire alarm system operation.
 - 2) Certification of seismic restraints.
 - 3) Receipt of O&M documentation package.
 - 4) Receipt for instruction of operating personnel.
 - 5) Fire alarm system test report.
 - 6) Air sampling smoke detector test report.
7. Construction Documents:
 - a. Record drawings.
 - b. Approved submittals, including revised shop drawings indicating field and as-installed conditions.
 - c. Equipment identification charts and schedules.
 - d. Warranty certificates.
 - e. Inspection certificates.
 - f. Performance verification report.
- E. Submit a receipt signed by the Owner acknowledging receipt of the operation and maintenance documentation package.
- F. Provide metal cabinets mounted on the wall adjacent to system control unit to house the operation and maintenance documentation package. Cabinets shall be approximately 12" wide x 18" high x 6" deep constructed of 18 gauge sheet metal with hinged door with latch. Cabinets shall be painted red and shall be labeled with 0.5" stenciled letters.

3.13 DIAGRAMS

- A. Frame and mount the fire alarm system diagrams at the fire alarm control panel.
- B. Diagrams shall be type written or computer generated.

- C. Diagrams shall be as-built and shall include interfaces and interlocks with other equipment.

3.14 RECORD DRAWINGS

- A. Refer to Section 017839, Project Record Documents.

3.15 MAINTENANCE

- A. Equipment operated prior to the date of the Architect's final certificate shall be maintained in accordance with manufacturers' recommendations.

3.16 INSTRUCTION OF OPERATING PERSONNEL

- A. Conduct formal instruction sessions for operating personnel. Conduct two similar sessions. The first session shall be conducted at the time of start-up and check-out, and the second session shall be approximately 2 months later. Sessions shall be a minimum of 2 days duration for basic electrical systems, and as specified herein for other systems and equipment. Sessions shall be conducted at the site.
- B. Prepare and submit a syllabus describing an overview of the program, describing how the program will be conducted, when and where meetings are to be held, names and company affiliations of lecturers, description of contents and outline for each lecture, and recommended reference material and outside reading. Obtain direction from the Owner on which operating personnel shall be instructed in each system. Proposed training schedules, materials, and lesson plans shall be submitted to the Owner for review.
- C. Sessions shall include:
1. General familiarization and operating procedures for the entire fire detection and alarm installation.
 2. Routine maintenance procedures for equipment.
- D. Factory-trained technicians shall give operating and maintenance instructions on the following systems and equipment:

<u>System/Equipment</u>	<u>Minimum Session Duration, hours</u>
Rescue assistance communication system	4
Fire alarm system	8

- E. Provide DVD format video recordings of training sessions and a complete record copy of all training materials, handouts, and other printed materials used in each training session.
- F. Training shall occur after testing is complete, unless approved otherwise by the Architect.
- G. Obtain receipt acknowledging completion of each item of instruction.

END OF SECTION 283010

COVER SHEET FOR
SUBMITTALS TO NEWCOMB & BOYD

Project: _____ Date: _____

Item: _____ Submittal Number: _____

Manufacturer: _____ Model: _____

Specification Paragraph and/or Drawing Number: _____

Capacity: _____

Electrical Characteristics (including identification of all separate connections or services required): _____

Accessories: _____

Options: _____

Deviations (if any; if none, state so): _____

General Contractor Approval: _____

SECTION 283090 – FIRE DETECTION AND ALARM PERFORMANCE VERIFICATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other fire detection and alarm systems are specified in other Sections of Division 28.
- B. Performance verification is an ongoing process and shall be performed throughout construction. Performance verification verifies that systems are operating in a manner consistent with the Construction Documents.
- C. This Section covers fire detection and alarm systems performance verification, as required to demonstrate that the equipment and fire detection and alarm systems of Division 28 are ready for safe and satisfactory operation, as defined by the Construction Documents. Performance verification shall include, but shall not be limited to, identification of equipment, cleaning, start-up, check-out, testing and adjusting of systems, preparation of equipment and systems documentation and of maintenance and operation manuals, Owner training, and preparation of record drawings.
- D. Fire detection and alarm performance verification shall conclude with the completion of required deferred testing, training, and system documentation as specified herein and required to demonstrate the proper operation of the fire detection and alarm equipment and systems provided by this Division. This Section includes responsibilities and obligations in support of performance verification and general commissioning requirements.
- E. Verify the performance of the following systems and equipment:
 - 1. Section 283100, Fire Alarm System.
 - 2. Section 283200, Air Sampling Smoke Detectors.
 - 3. Section 283300, Rescue Assistance Communication System.
 - 4. Section 283400, Emergency Responder Radio Coverage System.

1.2 QUALITY ASSURANCE

- A. Provide a Fire Detection and Alarm Performance Verification Supervisor with 10 years experience in fire detection and alarm contracting. The Fire Detection and Alarm Performance Verification Supervisor shall become familiar with the Owner's project requirements and the requirements of the performance verification process as defined in this Section and if applicable, the commissioning process defined in Division 29. The Fire Detection and Alarm Performance Verification Supervisor shall coordinate and execute the required performance verification activities.
- B. The Fire Detection and Alarm Performance Verification Supervisor shall review submittal data for conformance with the requirements of the Project, shall monitor compliance with the requirements specified herein for storage and protection of equipment during construction, shall authorize the initial starting of equipment and systems in a manner to avoid damage to equipment, shall oversee start-up, testing, and shall document that the scheduled and specified performance requirements of each system have been accomplished.
- C. Conform to the following:
 - 1. ASHRAE Guideline 0.2-2015, Commissioning Process for Existing Systems and Assemblies.
 - 2. ASHRAE Guideline 4-2019, Preparation of Operating and Maintenance Documentation of Building Systems.

3. NECA 90-2015.

1.3 PERFORMANCE VERIFICATION

- A. The Fire Detection and Alarm Performance Verification Supervisor shall be responsible for scheduling, supervising, and coordinating and executing the start-up, testing, and performance verification activities as specified herein. Include and itemize the cost of performance verification in the contract price, and in each purchase order or subcontract written, include requirements for submittal data, performance verification efforts and documentation, operations and maintenance data, and training as specified herein.
- B. Fire detection and alarm performance verification shall take place in three phases. Performance verification requirements for each phase are as follows:
 - 1. Construction Phase:
 - a. Attend a performance verification scoping meeting and additional performance verification meetings, initially scheduled monthly until prefunctional testing of equipment and systems begins, and weekly thereafter during the construction phase to facilitate the performance verification process. The Fire Detection and Alarm Performance Verification Supervisor shall coordinate meeting attendance.
 - b. Report in writing to the Architect, at least as often as performance verification meetings are scheduled, concerning the status of his activities as they affect the performance verification process, the status of each discrepancy identified during the prefunctional and functional testing process, explanations of any disagreements with the identified deficiencies, and his proposed resolution and schedule for correction of the deficiency.
 - c. Provide documentation of installed systems and equipment and develop functional testing procedures. This documentation shall include detailed manufacturer installation, start-up, operating, troubleshooting and maintenance procedures; full details of any Owner-contracted tests; full factory testing reports, if any; and full warranty information, including responsibilities of the Owner to keep the warranty in force. In addition, the installation, start-up and check-out materials that are actually shipped inside the equipment and the actual field check-out sheet forms to be used by the factory or field technicians shall be submitted to the Architect.
 - d. Develop and submit to the Architect for review and comment, prior to equipment or system start-up, a complete start-up and initial check-out plan using manufacturer's start-up procedures and prefunctional checklists for the performance of the equipment to be verified.
 - e. Assist in clarifying the proposed operation and control of equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
 - f. Prepare the specific functional test procedures as specified herein and review the proposed functional test procedures to ensure feasibility, safety, and equipment protection, and provide necessary written alarm limits to be used during the tests. Obtain Architect approval for proposed functional test procedures.
 - g. Prepare a preliminary schedule for performance verification activities, including equipment start-up, and testing, adjusting start and completion, and update the schedule during the construction period, as appropriate. Notify the Architect immediately when the verification activities not yet performed or not yet scheduled will delay construction.
 - h. Provide start-up and prefunctional testing for equipment and execute the fire detection and alarm-related portions of the prefunctional checklists for the verification of the performance of all the equipment during the start-up and initial check-out process.
 - i. Perform and document start-up and system operational check-out procedures, providing a copy to the Architect.
 - j. Correct noncompliance items before beginning functional testing. Discrepancies and problems shall be remedied before functional testing.

2. Acceptance Phase:
 - a. Place equipment and systems into operation and continue their operation during each working day of the testing and verification activities, as required.
 - b. Provide skilled technicians to execute starting and prefunctional testing of equipment and to execute the functional tests for each individual piece of equipment and system. Technicians shall be available and present during the agreed upon scheduled tests and for sufficient duration to complete the necessary tests, adjustments and problem solving.
 - c. Perform functional testing for specified equipment and interpret the test data, as necessary.
 - d. Correct deficiencies (differences between specified and observed performance) as identified and interpreted by the Architect and retest the equipment, as required to demonstrate proper operation and performance.
 - e. Prepare operation and maintenance manuals as specified, including clarifying and updating the original sequences of operation to as-built conditions.
 - f. Maintain marked-up record drawings and produce final record drawings of project drawings and contractor-generated coordination drawings.
 - g. Provide specified training of the Owner's operating personnel.
 - h. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
3. Warranty Period:
 - a. Execute deferred functional testing (after coordinating activity with the Performance Verification Supervisor).
 - b. Correct deficiencies and make necessary adjustments to operations and maintenance manuals and as-built drawings system or equipment modifications made during the warranty period and those identified in any deferred functional performance testing.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Standard testing equipment required to perform start-up, initial check-out, prefunctional, and required functional performance testing shall be provided by the contractor for the equipment or system being tested.
- B. Test equipment shall be of the quality and accuracy required to test and/or measure system performance with the tolerances specified and shall have been calibrated within the last 12 months, or as specified herein. Equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates available on request. Accuracy of sensors shall be at least twice that of the instrumentation being tested.

PART 3 - EXECUTION

3.1 SUBMITTALS

- A. Submit additional documentation as required to support the performance verification process. This additional submittal documentation shall include, at a minimum, the proposed start-up and initial check-out procedures, and prefunctional checklists.

3.2 START-UP PLAN AND PREFUNCTIONAL TESTING

- A. Prefunctional testing shall be required for each piece of equipment to ensure that the equipment and systems are properly installed and ready for operation, so that functional testing may proceed without delays. Follow the approved start-up, initial check-out, and prefunctional testing procedures. Sampling strategies shall not

be used for prefunctional testing. The prefunctional testing for equipment and subsystems of a given system shall be successfully completed and documented prior to functional testing of the system.

- B. The following procedures shall apply to equipment and systems where the performance is to be verified:
1. Start-up and initial check-out plan: develop the detailed start-up and prefunctional testing plans for equipment and systems that are to be verified, as specified herein. Review the proposed procedures and prefunctional testing documentation to ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed.
 2. The start-up and initial check-out plan shall consist, as a minimum, of the following:
 - a. The manufacturer's standard written start-up and check-out procedures copied from the installation manuals and manufacturer's normally used field check-out sheets. The plan shall include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan.
 - b. First-run checklist for equipment, including:
 - 1) Equipment properly set.
 - 2) Equipment properly connected.
 - 3) Wiring properly connected.
 - 4) Electrical overload relays appropriate for load.
 - 5) Electrical accessories properly installed and adjusted.
 - 6) Controls, safeties, and time switches properly set.
 - c. Contractor-developed prefunctional checklists.
 3. Prior to energizing, test cables and wiring for continuity, shorts, and circuitry, and correct short circuits, opens, and errors in circuiting.
 4. Overcurrent Protective Devices:
 - a. Set field-adjustable devices for trip settings providing maximum coordination, subsequent to installation of units.
 - b. Prior to energizing overcurrent protective devices, test devices for continuity of circuitry and for short circuits. Correct malfunctioning units.
 5. Start-up equipment and check-out operation in accordance with manufacturer's published procedures and with the procedures specified herein.
 - a. Submit report on equipment start-up and check-out with data from recorded findings.
 6. Grounding:
 - a. Ground resistance shall be measured by a licensed professional engineer in accordance with IEEE 81-2012. Measurements shall be made with the grounding system isolated from the utility neutral. Results of the tests shall be submitted in a certified test report, bearing the seal of the test engineer. The certified test report shall include the following minimum data:
 - 1) Project name, date and location of test.
 - 2) Instrument serial number and type used.
 - 3) Sketch, showing layout of ground system and locations of test spikes.
 - 4) Measured ground resistance.
 7. Fire Alarm System:
 - a. Procedures, methods, and testing of the fire alarm system shall be conducted in accordance with NFPA 72-2013.
 - b. Alarm initiating, notification, and auxiliary devices shall be tested to ensure they are operational and that alarm outputs are as specified herein. Devices and circuits shall be tested in both normal and trouble modes. Smoke detectors shall be tested using smoke, or a listed aerosol acceptable to the manufacturer. Smoke detectors that are part of a smoke control system shall be tested at minimum and maximum airflow quantities.

- c. Alarm initiating, notification, and auxiliary devices shall be tested to ensure they are annunciating the proper device label at the fire alarm control panel and/or remote annunciator display. This includes verification of the proper address, device description, and location. If the device labels are found to be inaccurate, correct and retest.
 - d. Verify the transmission of alarm, trouble, and supervisory signals to the central station.
 - e. SLC, NAC, and IDC circuits shall be tested for opens, shorts, and ground conditions, and the proper annunciation. Circuit board jumpers in the system that inhibit checking for ground faults shall be identified and shown to be in the correct position.
 - f. Auxiliary system functions shall be verified, including but not limited to elevator recall, control of HVAC systems, smoke control systems, fire or smoke doors/dampers/shutters, and the monitoring of the fire pump.
 - g. Significant portions of the testing shall be conducted on battery power. This includes the main control panel, and remote equipment such as network nodes, and/or auxiliary power supplies.
 - h. Site specific software shall be verified during testing of the sequence of operations.
 - i. Operational tests shall be conducted at a time coordinated between the Owner, Architect, Contractor, and the local authority having jurisdiction. The manufacturer's authorized representative for the fire alarm equipment shall be present during the tests. The manufacturer's authorized representative for auxiliary equipment monitored or activated by the fire alarm system shall also be present during the tests. This may include but is not limited to HVAC controls, elevators, suppression systems, fire pumps, and sprinkler systems. If the building is occupied prior to the operational test, these tests shall be conducted after normal business hours. Failure of the system to operate as specified herein shall require retesting.
 - j. Sound Output Levels:
 - 1) Finishes and furnishings shall be in place and building systems and equipment shall be in operation for these tests.
 - 2) Take sound level measurements throughout the building with a sound level meter to verify notification appliance sound output levels at a minimum of 15 dB above the ambient conditions. Provide a complete set of fire alarm shop drawings annotated to indicate the locations and sound level readings that were measured.
 - 3) For voice communications systems, set amplifiers to establish notification appliance sound output levels a minimum of 15 dB above the ambient conditions throughout areas covered by the system. Make adjustments within the capacity of the equipment provided, such as increasing amplifier output levels or adjusting device transformer taps, to meet the required performance in each area.
 - k. Submit a type test report, similar to that shown in NFPA 72-2013, recording test results, system descriptions, and witnesses.
 - l. Submit a printout of the event history log for testing.
- C. The Engineer reserves the right to witness the above described tests, checks and inspections. Notify the Engineer at least 10 days prior to the date scheduled for the tests.
- D. Four weeks prior to start-up, schedule equipment and systems start-up and check-out and notify the Architect in writing. The execution of the prefunctional checklists, start-up and check-out shall be directed and performed by the Contractor, in accordance with manufacturer's published procedures. The Architect shall be present for the start-up, check-out, and prefunctional testing of the first unit of each type of equipment, and any other tests he designates.
- E. Sensor calibration: calibration of sensors associated with a given piece of equipment or system shall be included as part of the prefunctional testing and listed on the appropriate test checklists and reports for that system.
- F. Completed start-up, check-out, and prefunctional test forms shall be completed and submitted to the Architect for review. List outstanding items of the initial start-up and prefunctional procedures that were

not completed successfully, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies shall be provided to the Architect within 2 days of test completion. The Architect shall review the Contractor's start-up and prefunctional testing reports and shall submit either a noncompliance report or an approval form to the Contractor. The Contractor shall correct items that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the Architect as soon as outstanding items have been corrected and resubmit an updated start-up report and a statement of correction on the original noncompliance report. When requirements are completed, the Architect shall recommend approval of the start-up and prefunctional testing of each system and schedule the functional testing of the equipment or system.

- G. Complete start-up and prefunctional testing for a system before functional testing of that system may proceed.

3.3 RETESTING OF EQUIPMENT AND/OR SYSTEMS

- A. Provide labor and materials required for retesting of any functional test found to be deficient.
- B. Prior to retesting, submit required data indicating that the deficient items have been completed and/or corrected to the Architect for approval and rescheduling of the functional test. If during the retesting it becomes apparent that the deficient items have not been completed and/or corrected as indicated in the data provided by the Contractor, the retesting shall be stopped. Costs for the design team to further supervise the retesting of a functional test shall be the responsibility of the Contractor.

3.4 DEFERRED TESTING

- A. Schedule and coordinate, with the approval of the Architect, any required tests delayed until building construction is completed, required building occupancy or loading, or other conditions are suitable for the demonstration of equipment or system's performance, as specified herein. Deferred testing shall be executed, documented, and deficiencies corrected as specified herein for functional testing. Adjustments or corrections to the operation and maintenance manuals and as-built documents required by the results of the testing shall be made before the testing process is considered complete.

3.5 TESTING DOCUMENTATION, NONCONFORMANCE, AND APPROVALS

- A. List outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the functional test procedure forms or on an attached sheet. Procedure forms and any outstanding deficiencies shall be provided to the Architect within 2 days of test completion. The Architect shall review the Contractor's start-up and prefunctional test reports and shall submit either a noncompliance report or an approval form to the Contractor. The Contractor shall work with the Architect to correct and retest deficiencies or uncompleted items. Correct items that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the Architect as soon as outstanding items have been corrected and resubmit an updated start-up report and a statement of correction on the original noncompliance report. When requirements are completed, recommend approval of the start-up and prefunctional testing of each system and schedule the functional testing of the equipment or system.
- B. As functional performance testing progresses and deficiencies are identified, work with the Architect to resolve the issues.

3.6 OPERATION AND MAINTENANCE DOCUMENTATION PACKAGE

- A. The Fire Detection and Alarm Performance Verification Supervisor shall compile and prepare documentation for fire detection and alarm equipment and systems covered in Division 28 and deliver this

documentation for inclusion in the operation and maintenance manuals prior to the training of the Owner's personnel.

3.7 INSTRUCTION OF OPERATING PERSONNEL

- A. The Fire Detection and Alarm Performance Verification Supervisor shall schedule, coordinate, assemble and deliver the documentation of the training required by this Division.

3.8 FUNCTIONAL TESTING

- A. Functional test requirements for the demonstration of proper system and equipment operation shall be defined by the Fire Detection and Alarm Performance Verification Supervisor. Execution of these tests and demonstrations of the required performance shall be the responsibility of the Contractor.
- B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or subsystems at the discretion of the Architect and Fire Detection and Alarm Performance Verification Supervisor. Beginning system testing before full completion of construction shall not relieve the Contractor from fully completing the system, including prefunctional checklists.
- C. Functional testing shall be completed and approved by the Architect before the Project will be considered substantially complete.

END OF SECTION 283090

SECTION 283100 - FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other fire detection and alarm systems are specified in other Sections of Division 28.
- B. This Section covers the fire alarm system.
- C. This Section includes fire alarm connections to alarm and supervisory devices furnished with the fire extinguishing systems which are specified in Division 21.
- D. Installation of duct smoke detectors is specified in Section 237000, Air Distribution. Detectors, electrical connections, and testing are specified in this Section.
- E. This Section includes responsibilities and obligations in support of performance verification specified in Section 283090, Fire Detection and Alarm Performance Verification and general commissioning requirements.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. North Carolina State Electrical Code-2017.
 - 2. NFPA 72-2013.
- B. Preparation of submittals, final panel connections, system programming, testing, certification, and operator training shall be performed by an authorized, factory-trained distributor or direct factory office of the equipment manufacturer.
- C. Control panels, audio equipment, and power supplies shall be the products of one manufacturer. Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of fire alarm equipment, and shall be items that have been in satisfactory use for at least 1 year. Equipment furnished shall be listed in accordance with UL 864-2014(R2018) for use in fire protective signaling systems.
- D. Fire alarm equipment and devices shall be furnished through a service provider that is a factory-authorized distributor or direct factory office of the equipment manufacturer. This service provider shall be located within 100 miles of the project site and shall be capable of providing on-site response to emergency calls within 8 hours. The service provider shall perform all functions relating to submittal preparation, system programming, final wiring connections at control panels, system testing and certification, and on-site operator training. The service provider shall employ at least 2 individuals who have been factory certified to program and maintain the fire alarm equipment to be installed and who hold current Level III or IV certifications in the Fire Alarm subfield by the National Institute for Certification in Engineering Technologies (NICET).
- E. Fire alarm equipment shall be the products of one of the following manufacturers: Edwards Systems Technology, Johnson Controls, Notifier, or Siemens.
- F. Installation shall be performed by an electrical contractor or fire alarm contractor with a minimum of 3 years' experience in fire alarm installation.

1.3 SUBMITTALS

- A. Submittals shall conform to NFPA 72-2013, and the requirements of Section 283010, Fire Detection and Alarm General.
- B. Submittals shall include a bill of materials, product data sheets, installation drawings, and calculations.
 - 1. Drawings shall be prepared using AutoCAD and shall show each floor in plan view to a scale not smaller than 1/8" = 1'-0". In plan views indicate the location of devices, approximate raceway routing between devices, conductor requirements in each section of raceway, the address of signaling line circuit (SLC) devices, the circuit number for notification appliances, wattage taps for speakers, and the intensity of strobe lights. Plan views shall include room identifications with room names and numbers. Provide hook-up details for fire alarm initiating and notification devices and indicate the wiring color code to be used. Include a system operating sequence in the form an I/O schedule. Provide control panel diagrams showing the arrangement of modular components and terminal connections for external wiring.
 - 2. Provide a riser diagram showing the interconnection of control panels, power supplies, and connection to the remote monitoring station.
 - 3. Product data sheets shall be submitted for all hardware, devices, cable, and wire and shall be marked to indicate the model numbers, modular components, and applicable options.
 - 4. Provide calculations for the voltage drop on notification appliance circuits, amplifier sizes, and battery sizes. Voltage drop calculations shall use as the starting voltage the battery voltage available after the batteries have operated the system in the quiescent and alarm modes for the specified duration of time.
 - 5. Submit a letter from the remote supervising station indicating that they have receiving equipment that is UL listed for receipt of signals from this fire alarm system.

1.4 SYSTEM FEATURES AND CONFIGURATION

- A. The fire alarm system shall employ addressable initiating devices and multiplex communication techniques. The point address of each device shall be set either at the device or at the control panel and shall be independent of the relative location of the device on the signaling line circuit. The system shall operate at 24 V DC when provided with 120 V AC primary power. SLCs shall be arranged for Class A operation in accordance with NFPA 72-2013. Signaling line circuits shall be designed so that a single wire to wire short does not disable more than 50 devices. Alarm notification appliance circuits (NACs) shall be arranged for Class A operation in accordance with NFPA 72-2013.
- B. The fire alarm system shall stand alone and shall be independent of other building systems and data communications links. Software routines necessary to perform auxiliary functions such as fan control and elevator recall shall reside within the fire alarm system. Operation of these auxiliary functions shall be initiated through addressable control modules, configured as relays, located adjacent to the controlled equipment.
- C. Occupant notification and evacuation will occur throughout the building on an all-call basis. The pathway survivability level shall be 0 as defined by NFPA 72-2013.
- D. The fire alarm system shall include, but not be limited to, the following operating features:
 - 1. At least 3 levels of password protection for program access and changes.
 - 2. Control-by-event programming whereby the receipt of an alarm from any point may be programmed to operate any or all control points on the system. The program shall allow input/output control based on ANDing, ORing, and time-of-day.
 - 3. Bypass and restore any detection or control point separately.
 - 4. A historical event log for view or print to store events in chronological order. The capacity of the historical event log shall be at least 50 percent greater than the system total addressable point count.

5. Fully site-programmable using a keypad or portable computer. Programming changes shall be stored in nonvolatile memory.
6. Real-time nonvolatile clock. System displays shall be annotated with time and date.
7. Drift compensation to automatically maintain the desired sensitivity level of analog detectors. Adjust for accumulation of contaminants and other environmental effects that would increase or decrease the detector sensitivity.
8. Maintenance alert to signal when the sensitivity compensation of an individual analog device is nearing the allowable limit.
9. Power-limited signaling line and notification appliance circuits.
10. On-demand status reports for each system point including:
 - a. Device type.
 - b. Custom message.
 - c. Status.
 - d. Sensitivity (analog only).
 - e. Address.
11. Individual English-language message display for each device. The display shall include the time, date, device type, and status in addition to a user-defined message up to 80 characters in length.
12. Ground fault detection.
13. Placement supervision of sensors and control panel components. The panel shall report by address any sensor removed from the system. Operation of other sensors shall not be affected.
14. Electrical supervision of SLCs, initiating device circuits (IDCs), NACs, primary power supply, and battery placement.
15. Audible trouble indicator, silence switch, and trouble LED.
16. Alarm silencing switch. This switch shall be overridden upon activation of a subsequent device and the alarm devices shall be re-activated. The switch shall silence audible alarms and turn off strobe lights.

PART 2 - PRODUCTS

2.1 FIRE ALARM CONTROL PANELS

- A. Control panels shall be listed in accordance with UL 864-2014(R2018). Panels shall be microprocessor-based and shall include plug-in modular components installed in a surface-mounted steel cabinet with hinged door with cylinder lock. Panel annunciation devices and visible indicators shall be visible when the door is closed. The primary annunciation device shall be a backlighted liquid crystal display (LCD) with operator keypad. Provide master system function keys including, but not limited to, Acknowledge, Reset, Silence, and Trouble Silence. A switch shall be provided for testing LED visible indicators. Controls and switches shall be identified with labels. Hand lettering is not acceptable.
- B. Power supplies shall have sufficient capacity to operate audible and visible notification appliances simultaneously for the specified duration of time.
- C. Provide fused circuits for regulated 24 V DC auxiliary power to electromagnetic door holders 4-wire detection devices, and heavy duty switching relays. Operating power to 4-wire detection devices shall be supervised.
- D. Provide signaling line and notification appliance circuits arranged so that the connected load on any circuit does not exceed 80% of rated circuit capacity.
- E. Circuit conductors entering or leaving the control panel shall be connected to screw-type terminals with each terminal marked for identification.

- F. Provide a remote audible trouble indicator with a minimum sound level output rating of 75 dBA at 10'. The device shall operate in conjunction with the control panel's integral trouble signal and shall be silenced by the system trouble silence switch. A rigid plastic, phenolic or metal identification sign which reads "Fire Alarm System Trouble" shall be provided at the audible appliance.
- G. Provide the following fire alarm signal:
 - 1. ANSI S3.41 3-pulse temporal evacuation pattern synchronized throughout the building.
 - 2. Non-coded, single-stroke chime tone synchronized throughout the building.
 - 3. Three rounds of a single-stroke chime tone followed by a recorded voice message. The sequence of tone and voice message shall be repeated until manually silenced.
- H. Provide a digital audio system, including supervised primary amplifiers standby amplifiers, and tone generators. Amplifier sizing shall be based on operating speakers throughout the building simultaneously. The connected load on any amplifier shall not exceed 80% of the amplifier rated power output capacity. Load voltage shall be 25 V RMS. Upon failure of a primary amplifier, a standby amplifier shall automatically assume the load and a trouble condition shall be annunciated on the system.
 - 1. Controls shall include a preamplifier, a hand-held microphone with press-to-talk button and coil cord, and switches to select active paging zones. Provide a switch for each paging zone as well as an all-call switch.
- I. Provide a multiple-message, digital voice record and playback system to broadcast fire alarm messages. The playback system shall include capacity to record and retrieve 3 individual messages, each up to 30 s in length. Messages shall provide a natural voice tone and shall be stored in nonvolatile memory. The volume of voice messages and alert tones shall be at the same decibel level. Each message shall be recorded in its entirety without stringing of vocabulary. Submit a .WAV file containing the tones and voice messages used in the system. Store in the fire alarm Document Box. Voice messages recorded using the system microphone are not acceptable.
- J. Provide 6 programmable switches for manual control of air handling unit shut down, air handling unit shut down bypass, and elevator recall bypass. Unused switches shall be spares. Each switch shall include a status LED for each position and a permanent identification label. Placing a switch in an off-normal position shall initiate a trouble signal on the fire alarm control panel.

2.2 STORAGE BATTERIES

- A. Storage batteries shall be sealed, lead-acid type requiring no additional water. Batteries shall have capacity, with primary power disconnected, to operate the fire alarm system under quiescent load for a period of 24 hours and thereafter operate audible and visible notification devices in an all-call mode for a period of 15 min. Batteries shall be sized to deliver 25% more ampere/hours based on a 24 hour discharge rate than required for the calculated capacities. Batteries shall be located in the bottom of the control panels or in a separate cabinet. All batteries shall be permanently marked with the date of manufacture.
- B. The battery charger shall be completely automatic, with high/low charging rate, capable of restoring the batteries from full discharge to full charge within 48 hours. The charger shall be located within the control panel or battery cabinet.

2.3 MANUAL FIRE ALARM PULL STATIONS

- A. Manual fire alarm pull stations shall conform to the applicable requirements of UL 38-2008. Stations shall be addressable, double action single stage type installed on semiflush-mounted outlet boxes. The housing shall be finished in red, with raised letter operating instructions of contrasting color. Stations requiring the breaking of glass or plastic panels for operation are not acceptable. The use of a key or wrench shall be required to reset the station. Stations shall have a separate screw terminal for each conductor.

2.4 AUTOMATIC FIRE DETECTING DEVICES

- A. Bases for automatic fire detection devices shall have screw terminals for wiring connections.
- B. Heat Detectors:
 - 1. Heat detectors shall be designed for detection of fire by fixed temperature principle. Detectors located in areas subject to moisture, exterior atmospheric conditions or hazardous locations shall be types approved for such locations. Heat detectors located in spaces where ambient temperatures may exceed 100°F shall be intermediate temperature rated.
 - 2. Heat detectors located in elevator hoistways and elevator equipment rooms, and which initiate an elevator shunt trip, shall be listed for a maximum spacing of 40' and have a temperature rating of 135°F.
- C. Smoke Detectors:
 - 1. Smoke detectors specified in this section include area type, and duct-mounted devices. Area and duct-mounted detectors shall be point-addressable type listed in accordance with UL 268-2016. Area type and duct-mounted smoke detectors shall operate on the photoelectric principle. Detectors shall contain a visible LED which shall pulse when the unit communicates with the signaling line circuit and is continuously illuminated when the unit is in alarm condition. Detectors shall be plug-in design in which the detector base contains terminals for making wiring connections. Where indicated on the Drawings, provide remote LED indicators. Remote alarm LEDs shall have a flush-mounted faceplates with white finish and shall be identified with a permanent label indicating the SLC address.
 - 2. Photoelectric smoke detectors shall operate on a light scattering principle using an LED light source. Failure of the LED shall not cause an alarm condition. Detectors shall have an obscuration rating within the limits prescribed by UL 268-2016.
 - 3. Duct smoke detectors shall include an enclosure, mounting hardware, perforated air intake sampling tube, and exhaust tube. The air intake tube shall extend through the far side of the duct and shall be plugged with a removable stopper or cap. Detectors shall be listed for airstream velocities up to 4000 fpm. Provide a remote LED and test switch with a white faceplate and address label for each duct smoke detector.

2.5 SIGNALING LINE CIRCUIT INTERFACE DEVICES

- A. The system shall include addressable input and output modules to perform control functions and supervise the open alarm contacts of nonaddressable initiating devices. Unless otherwise indicated on the Drawings, provide an individual input module for each nonaddressable initiating device. Wiring between the input module and the initiating device shall be arranged for Class B operation. Output modules shall be configured as Form C dry contact relays. Each module shall mount in a standard outlet box and shall include a status LED, a terminal strip for external wiring connections, and a faceplate for an identification label. Status LEDs shall be visible without removing faceplates. The label shall indicate the module function and address.
- B. Line fault isolator modules shall detect a fault on the signaling line circuit and interrupt power to devices installed beyond the isolator. When the fault has cleared, the isolator shall reset automatically. Isolator modules shall be installed in a visible location. Faceplate and labeling requirements shall be similar to other SLC interface devices.
- C. Where multiple monitor or control functions must be performed within the same area, a packaged multiple-circuit input/output module may be used. The packaged device shall communicate directly with the signaling line circuit and shall provide independently addressable monitor and control points, terminal strips for external wiring connections, and a protective enclosure.

- D. Where the rated current capacity of the output module is insufficient to connect directly to the controlled equipment, provide an intermediate 24 V DC plug-in control relay with dustproof cover, terminal strip for coil and contact connections, and painted steel enclosure designed for wall mounting. The enclosure shall be identified with a permanent label. Operating power for the relay coil shall be supervised by the SLC.

2.6 NOTIFICATION APPLIANCES

- A. Notification appliances shall be UL listed under the following standards, as applicable:
 - 1. UL 464-2016, UL 1480-2016, or UL 1971-2002 (R 2013).
- B. Fire Alarm Speakers:
 - 1. Speakers shall be flush- mounted on the ceilings and walls. Provide a matching backbox with enamel finish for surface-mounted units. Speakers shall be 4" diameter, and shall have a frequency response of 400 Hz to 4000 Hz and matching transformer with multiple power taps in the range of 0.25 W to 2 W. Ceiling-mounted devices shall include a moisture-resistant paper cone speaker, speaker enclosure, and round perforated baffle plate with white enamel finish. Wall-mounted speakers shall include a square perforated grille with white enamel finish.
- C. Fire Alarm Bells:
 - 1. Bells shall be surface-mounted with a mounting backbox. Bells shall be 6" continuous, vibrating, underdome design producing a minimum output rating of 85 dBA at 10'. Bells in exterior locations shall be specifically listed or approved for outdoor use and shall be mounted on a weatherproof outlet box. Provide an impressed plastic ID sign with white letters on a red background. Lettering to be minimum 1" high to read "SPRINKLER WATER FLOW ALARM".
- D. Visible Notification Appliances:
 - 1. Visible notification appliances shall be strobe lights with a Xenon flash tube, clear optic lens, and identification "FIRE" in a contrasting color. Strobe intensity shall be field selectable within a range of 15 candela to 95 candela. Strobes shall flash at approximately 1 flash per s. Strobes shall be semiflush- mounted on the walls and ceilings and shall include a white faceplate. Strobe lights throughout the building shall flash at a synchronized rate. Synchronization shall be maintained as long as strobe lights are operating.
- E. Combination Audible/Visible Notification Appliances:
 - 1. Combination audible/visible notification appliances shall provide the same performance characteristics as specified herein for individual units, except that they shall mount in a single factory-assembled enclosure.

2.7 FIRE ALARM ANNUNCIATORS

- A. Alphanumeric Annunciators:
 - 1. Alphanumeric annunciators shall consist of a backlighted LCD, an audible device, and an operator keypad in a flush- mounted enclosure. The display shall consist of a minimum of 80 characters which shall mimic all messages on the fire alarm control panel. A keypad shall allow the operator to scroll forward or backward through the messages. Provide a switch to silence the internal audible device.

2.8 WIRE, CABLE, AND RACEWAY

- A. Wiring:

1. Wiring for 120 V AC power shall be #12 AWG minimum with 600 volt insulation. Refer to Section 261200.
2. Cables shall conform to UL 1424-2015 "Standard for Cables for Power-Limited Fire Alarm Circuits".
3. Wiring for visible and audible notification appliance circuits (except speakers) shall be Type FPL/FPLR, solid copper, #14 AWG minimum.
4. Wiring for signaling line circuits shall be Type FPL/FPLR, solid copper, #18 AWG minimum. The capacitance shall not exceed 35 pf/ft between conductors.
5. Wiring for speaker circuits shall be Type FPL/FPLR, solid copper, twisted pair, minimum #18 AWG. Wiring shall be shielded if recommended by the fire alarm manufacturer.
6. Wiring shall conform to the published performance criteria of the fire alarm manufacturer.

B. Raceway:

1. Fire alarm wire and cable shall be installed in galvanized steel electrical metallic tubing (EMT) minimum 0.75" size. Couplings shall be galvanized malleable iron or galvanized steel with insulated throats.
2. Flexible EMT shall be galvanized steel with twist-in, insertion, or totally enclosed couplings. Liquid tight flexible EMT shall have a neoprene outer jacket.
3. Boxes shall be code-gauge galvanized steel.

2.9 PERIPHERAL EQUIPMENT AND ACCESSORIES

A. Electromagnetic Door Holders:

1. Two-piece electromagnet type attached to the walls and door. Door holders shall operate on 24 V DC power from the fire alarm control panel. The door component shall include an adjustable contact angle and a nylon pivot bearing. Magnets shall have a holding force of approximately 25 lbf. Housings shall be brushed aluminum.

B. Auxiliary Power Supplies:

1. Auxiliary power supplies shall provide power for notification appliances and other 24 V DC power requirements. Power supplies shall be UL listed, packaged units with surface-mounted steel enclosures, multiple fused notification appliance circuits, transformers, rectifiers, power indicator LED status lights, automatic battery chargers, and standby batteries with 24-hour capacity. Loss of power, low battery voltage, or a supervision fault on a notification appliance circuit shall be annunciated through dry contacts. At the contractor's option, auxiliary power supplies may be directly compatible with an addressable signaling line circuit for activation and annunciation of off-normal conditions. Input power shall be 120 V AC.

C. Fire Alarm Terminal Cabinets:

1. UL listed, surface-mounted steel enclosure with hinged door, key lock, 0.5" and 0.75" conduit knockouts, red finish, and white lettering "FIRE ALARM TERMINAL CABINET". The cabinet shall contain an 18 point (minimum) high barrier terminal strip and labeling ID card.
 - a. Manufacturer: Space Age Electronics TC1.

D. Surge protective devices: surge protective devices shall be hard wired and shall have a response time of less than 5 ns. Surge protection devices shall be installed in a steel NEMA enclosure with a hinged door. Provide an identification label.

1. AC Voltage Power Surge Protective Devices:

- a. Performance in accordance with IEEE C62.41.1-2002 (R2008) and IEEE C62.41.2-2002 (COR 1-2012).
- b. Listed in accordance with UL 1449-2014(R2018).

- c. Configured for 120 V, 1-phase, 2-wire with ground (minimum 15 A).
 - d. Maximum clamping voltage shall not exceed 350 V.
 - e. Installed in a UL listed metal enclosure.
 - 2. Communication or Signal Conductor Surge Protective Devices:
 - a. Listed in accordance with UL 497B-2004.
 - b. Maximum clamping voltage shall not exceed the normal applied voltage by more than 150%.
 - c. Installed in a UL listed metal enclosure where conductors leave the building.
 - 3. Manufacturer: Ditek, Edco, Northern Technologies, or Transtector.
- E. Device Markers:
 - 1. Text shall be black on a white or clear background and shall be minimum 0.5" high. Hand lettering is not acceptable. Fire alarm SLC devices shall be identified with a printed adhesive label showing the device address. Fire alarm notification appliances shall be identified with a printed adhesive label showing the source panel and circuit number.
 - a. Manufacturer: Brother or equal.
- F. Keys and Locks:
 - 1. Keys and locks for control panels, power supplies, and terminal cabinets shall be identical. Provide 6 sets of keys.
- G. Document Box:
 - 1. The fire alarm document box shall be a surface-mounted steel cabinet with red enamel finish, hinged front door with key lock, holder for 8.5" x 11" paper documents, a CD case, and key ring hook. The outer face of the door shall be lettered "FIRE ALARM DOCUMENTS". Space Age Electronics Model FDB or equal.

2.10 REMOTE STATION CONNECTION

- A. Digital Alarm Communicator Transmitter (DACT): and Cellular Transmitter:
 - 1. Fire alarm system activity shall be reported to a UL listed remote station.
 - 2. Provide a UL listed digital communicator with contact ID format.
 - 3. Provide a UL listed cellular transmitter with standby 24 hour battery to take output from the DACT and report fire alarm activity to the remote station. The cellular transmitter shall be approved as the sole path of communication with the remote station. Supervisory check-in intervals shall meet NFPA 72-2013. This Section shall include annual monitoring fees and cellular service fees for a period of 1 year.

PART 3 - EXECUTION

3.1 GENERAL

- A. Primary Power Circuits:
 - 1. Primary 120 V AC power to fire alarm equipment shall be dedicated branch circuits. Branch circuits supplying fire alarm power shall have red marking and a breaker locking device.
- B. Wiring:
 - 1. Line voltage and power-limited circuits shall not be run in the same conduit.

2. Conductors used for the same functions shall be similarly color-coded. Wiring code color shall remain uniform throughout the circuit.
3. Wiring for the fire alarm system shall not be installed in conduits, junction boxes, or outlet boxes with conductors of any other building system. Fire alarm junction boxes and outlet boxes shall be painted red prior to pulling the wire. Circuit conductors entering or leaving any mounting box, outlet box enclosure or cabinet shall be connected to screw terminals with each terminal marked in accordance with the wiring diagram. Connections and splices shall be made using screw terminal blocks. The use of wire nut type connectors is prohibited in the system. Wiring within control panels shall be laced with cable ties. Final wiring connections to the control panel and application of operating power shall be made by the manufacturer's authorized representative.
4. End-of-line supervisory devices shall be mounted within dedicated outlet boxes with cover plated located in a visible location on a suspended ceiling or on the wall. The device shall be labeled "EOL" with the circuit number using the specified device marker.

C. Control Panels and Auxiliary Power Supplies:

1. Control panels and auxiliary power supplies shall be mounted so that no part of the enclosing cabinet is less than 12" nor more than 78" above the finished floor. Provide an engraved label on the door to indicate the panel and circuit number of the 120 V power source.
2. Operating instructions for the fire alarm control panel shall be printed and framed under glass adjacent to the control panel.

D. Conduit and Boxes:

1. Fire alarm wiring shall be installed in electrical metallic tubing (EMT).
2. Flexible EMT attached to fire sprinkler equipment shall be liquidtight with a neoprene jacket.
3. Where manual pull stations and notification appliances are surface-mounted, provide a matching backbox by the fire alarm manufacturer. Standard electrical outlet boxes shall not be used.

E. Install transient voltage surge suppression devices at the following locations:

1. On each branch circuit supplying 120 V power to fire alarm equipment.
2. On each fire alarm communication or signal conductor which leaves the building.

F. Weatherproof Devices:

1. Where exposed to the weather or high humidity, gasketed back boxes and enclosures shall be provided.

3.2 MANUAL FIRE ALARM PULL STATIONS

- A. Mount manual pull stations with the centerline 4' above finished floor.

3.3 AUTOMATIC FIRE DETECTING DEVICES

A. Area Smoke Detectors:

1. Detectors shall be installed in accordance with NFPA 72-2013. Detectors shall be at least 3' from supply or return air diffusers. During construction, smoke detectors shall be provided with protective covers to prevent the entry of dust and debris. Covers shall be removed prior to system acceptance testing.

- B. Smoke detectors on suspended acoustical tile ceilings shall be located in the center of the tile and shall be secured with a tile bridge.

C. Duct Smoke Detectors:

1. Remote status LEDs shall be mounted approximately 5' above the floor in an accessible location.
2. Seal the sheet metal penetrations caused by sample tubes.

D. Heat Detectors:

1. Where heat detectors are shown on the drawings in elevator equipment rooms and at the top of elevator hoistways, they shall be located within 24" of each sprinkler head in accordance with NFPA 72-2013.

3.4 NOTIFICATION APPLIANCES

- A. Wall-mounted visual notification appliances shall be mounted with the bottom of the strobe lens 6'-8" above the finished floor. For combination audible/visible appliances, mounting height shall be governed by the strobe light.
- B. Notification appliances on suspended acoustical tile ceilings shall be located in the center of the tile and shall be secured with a tile bridge.

3.5 SIGNALING LINE CIRCUIT INTERFACE DEVICES

- A. Control modules shall be installed within 36" of the device with which it is associated.

END OF SECTION 283100

SECTION 283300 - RESCUE ASSISTANCE COMMUNICATION SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other fire detection and alarm systems are specified in other Sections of Division 28.
- B. This Section covers the rescue assistance communication system, including equipment, installation, and wiring.
- C. The system shall provide 2-way voice communications pathways between remote station locations and a central control point.
- D. This Section includes responsibilities and obligations in support of performance verification specified in Section 283090, Fire Detection and Alarm Performance Verification and general commissioning requirements.

1.2 QUALITY ASSURANCE

- A. Components shall be UL listed and bear the UL listing mark.
- B. Conform to the following:
 - 1. ICC A117.1-2017.
 - 2. North Carolina State Electrical Code-2017.
 - 3. NFPA 72-2013.

PART 2 - PRODUCTS

2.1 COMMAND STATIONS

- A. Command stations shall include the following features:
 - 1. LED display that identifies the remote stations using a 40 character alphanumeric message or visual labels with LEDs for remote station monitoring.
 - 2. Hardwired telephone handset.
 - 3. Capability to call any one remote station or call all stations at once.
 - 4. Expandable to 256 remote stations.
 - 5. Flush wall-mounted.
 - 6. Capable of forwarding to remote telephone locations or 9-1-1 upon no answer at command station.
 - 7. Built-in self-test such that problems with remote stations are reported on the LED display.

2.2 PROCESSORS

- A. Processors shall have the following features:
 - 1. 120 V AC system controller.
 - 2. 20 min UPS back-up.

2.3 REMOTE STATIONS

- A. Remote stations shall have the following features:
1. IP66, vandal-resistant and water-resistant.
 2. Vandal-resistant red metal call button.
 3. Handsfree microphone and speaker rated for indoor and outdoor use.
 4. LED Call Placed light.
 5. LED Help Coming light.
 6. Cast metal letters and Braille signage reading CALL.
 7. 12 gauge stainless steel housing.

2.4 MANUFACTURER

- A. Commend, Stentofon, or Talk-A-Phone.

PART 3 - EXECUTION

3.1 GENERAL

- A. System installation shall be in accordance with the manufacturer's recommended installation procedures.

3.2 COMMAND STATIONS

- A. Coordinate the location with the Architect. Install command station in a flush-mounted box, at the location indicated on the Drawings.
- B. Program the system at the command station to indicate the remote stations as alphanumeric description of their location, e.g., Third Floor East Stairwell.
- C. Program the system at the command station to forward unanswered calls to 9-1-1 or the telephone number provided by the Owner.

3.3 REMOTE STATIONS

- A. Install remote stations in flush-mounted boxes at locations where the device is indicated on the Drawings to be installed in a wall of less than 2-hour construction.

3.4 SYSTEM CABLING

- A. Provide manufacturer recommended cabling. At a minimum, cabling shall be Category 5e, 24 AWG, rated for the installation environment.
- B. Install cables designed for the installation environment.
1. For each cable distribution application, install copper cables UL listed for the application.
 2. For cable distribution applications, including enclosures or raceways underground or in slabs on grade, install copper cables designed for use in wet locations.

END OF SECTION 283300

SECTION 283400 - EMERGENCY RESPONDER RADIO COVERAGE SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This specification describes performance criteria for deploying an Emergency Responder Radio Coverage System (ERRCS), also referred to as a Distributed Antenna System (DAS), capable of supporting Public Safety Networks (PSN).

1.2 SYSTEM DESCRIPTION

- A. Design and install an Emergency Responder Radio Coverage System throughout the building.
- B. The system conformance shall be coordinated with the local PSN AJH (Fire Marshall) and the First Responder Network Authority (FirstNet). At a minimum, the system shall comply with:
 - 1. 2018 North Carolina Fire Prevention Code.
 - 2. NFPA 72 – 2013.
- C. The system shall provide radio coverage for emergency responders within 95% of all areas of the building and 99% of Critical Building Areas. The DAS system will typically utilize a Donor Antenna mounted on the roof, connected to a Master Unit in the Equipment Room of the building, and distribute the RF signal throughout the floors with active and passive components. The DAS system will be designed to enhance the radio signal coverage of the associated New Hanover County public safety communications system to meet or exceed the radio signal requirements mandated in the 2012 IFC, Section 510, et al. The ERRCS shall support all 911 frequencies. At a minimum, an ERRCS will be provided for the following agencies:
 - 3. Paramedics / Emergency Medical Technicians (EMTs)
 - 4. Police Officers
 - 5. Firefighters

1.3 SYSTEM DESIGN AND INSTALLATION CRITERIA

- A. The system shall include, but not be limited to, a distributed antenna system with bi-directional amplifier(s). The DAS will be a broadband arrangement of coax cable, single mode fiber optic cable, base station unit, optical distribution units, remote units, directional couplers, power splitters, with indoor and outdoor antennas strategically positioned throughout the building to achieve minimal loss and optimal signal strength and maximum radio signal coverage. The DAS must be capable of remote monitoring solution that provides alarming, diagnostics and provisioning and control of the system.
- B. The Contractor providing equipment & installation services will provide a turn-key solution including but not limited to:
 - 1. Pre & Post installation testing, System Design.
 - 2. Engineering Services.
 - 3. Coordination with emergency services providers (Police, Fire, EMS)
 - 4. Amplifier infrastructure.
 - 5. Indoor & Outdoor Antenna Systems including Directional Couplers and/or Splitters.
 - 6. Coaxial Cabling & Connectors meeting or exceeding manufacturer's line-loss specifications.
 - 7. Lightning/Surge Suppression.
 - 8. Ancillary Equipment and any miscellaneous hardware or installation supplies required for job completion.

- C. The DAS shall not cause interference to other licensed FCC users in the Emergency Services frequency bands. The DAS shall be capable of modification or expansion in the event frequency changes are required by the FCC or additional frequencies made available by the FCC to New Hanover County.
- D. Approval prior to installation: Amplification systems capable of operating on frequencies licensed to any public safety agency by the FCC shall not be installed without prior coordination and approval of the fire code official or PSN Authority Having Jurisdiction (AHJ).
- E. FCC Compliance: The emergency responder radio coverage system installation and components shall also comply with all applicable federal regulations including, but not limited to FCC 47 CFR part 90.219.
- F. It is the Contractor's responsibility to ensure that the DAS complies with local code, ordinances or requirements established by the PSN AHJ and the First Responders Network Authority (FirstNet).
- G. Contractor shall provide a complete written description and schematic diagram of proposed DAS network and include specification sheets for all proposed equipment. Included within the design will be a written description of lightning and surge suppression measures.
- H. Installation services shall include tuning, alignment, optimization as needed. Installation services shall also include system testing & approval in association with the New Hanover County Fire Marshall's office.
- I. Equipment provided and installed shall include at minimum, a 1-year manufacturer warranty with the option for warranty extension for up to 5 total years.
- J. All installation work shall be coordinated with other trades. All roof penetrations shall be coordinated with the Construction Manager / General Contractor, and roof-mounted equipment locations shall be approved by the Architect prior to installation.

1.4 TECHNICAL AND PERFORMANCE REQUIREMENTS

- K. The DAS shall meet the following technical requirements:
 - 1. Minimum Radio Coverage into Building: A minimum voice quality of DAQ 3.4 (see TSB-88-B) (for Digital radio systems) and Circuit Merit 3 (for Analog systems) shall be present in all areas of the building when transmitted from the emergency radio system. The building shall be considered to have acceptable emergency responder radio coverage when signal strength measurements in 95% of all areas on each floor of the building and 99% of all Critical Building Areas as defined in Section 24.5.2.2.1 of the NFPA 72.
 - 2. Minimal Signal Strength out of the Building: The DAS shall be capable of enhancing the radio signal of the emergency responder's system so that a signal strength of -95 dBm or 20 dBm (± 5 dBm) over the noise floor, whichever is greater, shall be received within or transmitted from the building. For purpose of this section, 95% building coverage is considered to all areas of the building.
 - 3. Secondary power: Emergency responder radio coverage systems shall be provided with an approved secondary power source. The secondary power source shall be capable of operating the emergency responder radio coverage system for a minimum of 24 hours. When primary power is lost, the system shall automatically transfer to the secondary power source. If emergency power is not available, provide battery back-up sized to support the system for 24 hours minimum.
 - 4. Signal Booster requirements: All signal booster components shall be contained in a National Electrical Manufacturer's Association (NEMA) 4-type waterproof cabinet. Battery systems (if applicable) used for emergency power source shall be contained in a NEMA 4-type waterproof cabinet. The signal booster & secondary power source shall be electrically supervised & monitored through the Fire Alarm System, or when approved by the fire code official, shall sound an audible signal at a constantly attended location. Equipment shall have FCC certification prior to installation.

1.5 SUBMITTALS

A. Prior to Construction Contractor shall provide the following:

1. Qualifications in accordance with Quality Assurance requirements herein.
2. Product Datasheets.
3. For each required jurisdiction, provide statement of requirements including:
 - a. Primary contact.
 - b. Frequency or frequencies.
 - c. Signal Strength.
 - d. Repeater location and related donor antenna requirements.
 - e. Additional system requirements such as system supervision, inspectibility, if any.
4. RF Propagation Modeling.
 - a. Heat maps per frequency/signal type.
 - b. Documentation to describe and confirm the following:
 - 1) Propagation model details including coefficients.
 - 2) Building model details including materials.
 - 3) Evidence of modeling with simultaneous multiple signals to account for system loading.
5. Letter of approval of system design from the local public safety networks AHJ prior to system installation.
6. Shop Drawings: Submit the following items:
 - a. Overlay of system Component on floor plans.
 - b. Drawings of Donor Antenna and grounding.
7. Recommended Spares.
8. Warranty Documents:
 - a. Submit for all manufactured system components.
 - b. Submit contractor's system warranty.
9. Acceptance Test Plan (ATP), including but not limited to:
 - a. System readiness checklists.
 - b. Signal level testing.
 - c. AHJ acceptance testing.

B. Operation and Maintenance Documentation Package

1. As Built Drawings shall be provided to the Owner and the PSN AHJ in AutoCAD format in digital format and in two paper copies indicating:
 - a. Donor antenna, grounding and lightning protection.
 - b. Cable routing and coverage antenna locations.
 - c. Active component locations, layout and configuration.
2. Warranty Documents:
 - a. Submit for all manufactured System Components.
 - b. Submit Contractor's System Warranty.
3. Test Reports: Submit Accepted ATP reports by the PSN AHJ.

1.6 QUALITY ASSURANCE

- A. Qualifications & Certifications: The design and installation of an optimally functional DAS requires substantial radio frequency (RF) technical knowledge. Contractors must have the required qualifications within their organizations in order to be considered:
1. A valid FCC issued general radio operators license.
 2. Certification of in-building system training issued by a nationally recognized organization, school or a certificate issued by the manufacturer of the equipment being installed.
 3. Reference for at least two existing DAS or radio enhancement system installations of similar size and scope within a 25 mile radius of the project site.
 4. At least 25 years combined experience in the RF installation and services industry, whereas easily demonstrating adequate skills and experience to perform required installation, services and testing.
 5. 24/7 on call service with an on-site response time of two hours or less from initial service call.

1.7 SYSTEM MONITORING

- A. The system shall include automatic supervisory and trouble signals for malfunctions of the signal booster(s) and power supply(ies) that are annunciated by the Fire Alarm System as defined in Section 24.5.2.6 of the NFPA 72 and Section 510.4.2.4 of the IFC.

1.8 MAINTENANCE

- A. The Contractor shall provide an optional maintenance service contract, covering for a period of one-year: preventative maintenance, system monitoring, spares, fault mitigation, equipment repair, and response time.

PART 2 - PRODUCT DATA

2.1 PRODUCTS

- A. The ERRCS shall include broadband arrangement of coax cable, fiber optic cable, base station unit, optical distribution units, remote units, directional couplers, power splitters, with indoor and outdoor antennas tactically positioned throughout the building as needed to achieve minimal loss and optimal signal strength.

PART 3 - EXECUTION

3.1 RACEWAYS AND BOXES

- A. Install raceways and boxes in accordance with Section 261100, Raceways, Section 261300, Boxes, and TIA 569-D-1-2016.
1. Raceways and boxes shall contain a or Level 3 rating for Survivability per NFPA 72.
- B. Install wiring or cables in raceways where wiring or cables are otherwise exposed, including open ceiling spaces.

3.2 INSTALLATION

- A. The contractor shall design, install, commission and test the DAS in accordance with the manufacturer's instructions and recommendations.

- B. System Settings: The gain and power values of all Bi-Directional Amplifier (BDA)s shall be measured. The test measurement results shall be recorded on as-built drawings and kept on file with the Owner so that the measurements can be verified each year during the annual tests. In the event of lost measurement results, the building owner will be required to rerun the acceptance test to reestablish the gain values.

3.3 ACCEPTANCE TESTING

- A. Upon installation completion, system acceptance testing shall be performed in accordance with Section 510.5.3 (IFC). Testing shall be conducted using a calibrated portable radio of the latest brand and model used by the associated agency talking through the agency's radio communications system. A spectrum analyzer or other suitable test equipment shall be utilized to ensure spurious oscillations are not being generated by the subject signal booster. Electronic test reports shall be provided to the building owner and the fire official.

END OF SECTION 283400

